M.E. ECE (Digital Systems)

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	EC101	VLSI Design and Technology	3	0	0	30	70	3
Core-II	EC102	Micro Controller Architecture	3	0	0	30	70	3
Programme Elective-I	EC111	Advanced Computer Architecture	3	0	0	30	70	3
	EC112	Field Programmable Gate Arrays						
Programme Elective-II	EC113	VLSI Testing	3	0	0	30	70	3
	EC114	Wireless and Mobile Communications						
Audit-I	AC101	English for Research Paper Writing	2	0	0	30	70	0
	AC102	Sanskrit for Technical Knowledge						
	AC103	Value Education						
	AC104	Constitution of India						
Lab-I	EC151	Digital Systems Laboratory-I	0	0	3	50	-	1.5
	EC161	Seminar-I	0	0	3	50	-	1.5
Core	EC100	Research Methodologies in ECE	3	0	0	30	70	3
TOTAL			17	0	6	280	420	18
SEMESTER-II								
Core-III	EC103	VLSI Design Verification and Testing	3	0	0	30	70	3
Core-IV	EC104	Design of Fault Tolerant and Testable Systems	3	0	0	30	70	3
Programme Elective-III	EC115	Advanced Communication and Computer Networks	3	0	0	30	70	3
	EC116	Internet of Things						
Programme Elective-IV	EC117	Digital Design and PLDs	3	0	0	30	70	3
	EC118	Low Power VLSI Design						
Audit-II	AC105	Disaster Management	2	0	0	30	70	0
	AC106	Pedagogy Studies						
	AC107	Stress Management by Yoga						
	AC108	Personality Development through Life Enlightenment Skills						
Lab-II	EC152	Digital Systems Laboratory-II	0	0	3	50	-	1.5
	EC162	Seminar-II	0	0	3	50	-	1.5
	EC171	Mini Project with Seminar	0	0	6	50	-	3
TOTAL			14	0	12	300	350	18
SEMESTER-III								
Programme Elective-V	EC119	Analog and Mixed Signal IC Design	3	0	0	30	70	3
	EC120	VLSI Signal Processing						
Open Elective	OE 901	Field Programmable Gate Arrays Architecture	3	0	0	30	70	3
	OE 902	Smart Sensors						
	EC181	Major Project Phase I	0	0	20	100	-	10
TOTAL			6	0	20	160	140	16
SEMESTER-IV								
	EC182	Major Project Phase II	0	0	32	-	200	16
GRAND TOTAL								68

CIE : Continuous Internal Evaluation SEE : Semester End Examination

M.E. ECE (Systems and Signal Processing)

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	EC201	Advanced Digital Signal Processing	3	0	0	30	70	3
Core-II	EC202	Digital Image and Video Processing	3	0	0	30	70	3
Programme Elective-I	EC211	Computer Vision	3	0	0	30	70	3
	EC212	DSP Architecture						
	EC213	IOT and Applications						
Programme Elective-II	EC214	Wireless Sensor Networks	3	0	0	30	70	3
	EC215	Biomedical Signal Processing						
	EC216	Remote Sensing						
Audit-I	AC101	English for Research Paper Writing	2	0	0	30	70	0
	AC102	Sanskrit for Technical Knowledge						
	AC103	Value Education						
	AC104	Constitution of India						
Lab-I	EC251	Advanced Digital Signal Processing Lab	0	0	3	50	-	1.5
	EC261	Seminar-I	0	0	3	50	-	1.5
Core	EC100	Research Methodology in ECE	3	0	0	30	70	3
TOTAL			17	0	6	280	420	18
SEMESTER-II								
Core-III	EC203	Pattern Recognition and Machine Learning	3	0	0	30	70	3
Core-IV	EC204	Detection and Estimation Theory	3	0	0	30	70	3
Programme Elective-III	EC114	Wireless and Mobile Communication	3	0	0	30	70	3
	EC217	Audio Processing						
	EC218	Voice and Data Networks						
Programme Elective-IV	EC219	Adaptive Signal Processing	3	0	0	30	70	3
	EC220	Artificial Neural Networks						
	EC221	Optimization Techniques						
Audit-II	AC105	Disaster Management	2	0	0	30	70	0
	AC106	Pedagogy Studies						
	AC107	Stress Management by Yoga						
	AC108	Personality Development through Life Enlightenment Skills						
Lab-II	EC252	Digital Image and Video Processing Lab	-	-	3	50	-	1.5
Lab-IV	EC262	Seminar-II	0	0	3	50	-	1.5
	EC271	Mini Project with Seminar	0	0	6	50	-	3
TOTAL			14	0	12	300	350	18
SEMESTER-III								
Programme Elective-V	EC222	Coding Theory and Techniques	3	0	0	30	70	3
	EC111	Advanced Computer Architecture						
	EC223	Multi Spectral Signal Analysis						
Open Elective	OE 902	Smart sensors	3	0	0	30	70	3
	EC281	Major Project Phase I	0	0	20	100	-	10
TOTAL			6	0	20	160	140	16
SEMESTER-IV								
	EC282	Major Project Phase II	0	0	32	-	200	16
GRAND TOTAL								68

M.E. ECE (Microwave and Radar Engineering)

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	EC301	Advanced Electromagnetic Engineering	3	0	0	30	70	3
Core-II	EC302	Microwave Antennas	3	0	0	30	70	3
Programme Elective-I	EC311	Microwave Measurements	3	0	0	30	70	3
	EC312	Microwave Semiconductor Devices						
	EC114	Wireless and Mobile Communications						
Programme Elective-II	EC313	Satellite Radio Navigation	3	0	0	30	70	3
	EC314	RF MEMS						
	EC315	Computational Electromagnetics						
Audit-I	AC101	English for Research Paper Writing	2	0	0	30	70	0
	AC102	Sanskrit for Technical Knowledge						
	AC103	Value Education						
	AC104	Constitution of India						
Lab-I	EC351	Microwave Systems Laboratory-I	0	0	3	50	-	1.5
	EC361	Seminar-I	0	0	3	50	-	1.5
Core	EC100	Research Methodology in ECE	3	0	0	30	70	3
TOTAL			17	0	6	280	420	18
SEMESTER-II								
Core-III	EC303	Microwave Circuits and Systems	3	0	0	30	70	3
Core-IV	EC304	Principles of Radar Engineering	3	0	0	30	70	3
Programme Elective-III	EC316	Satellite and Microwave Communication	3	0	0	30	70	3
	EC317	Phased Array Radar						
	EC318	AD-HOC Wireless Networks						
Programme Elective-IV	EC319	Electromagnetic Interference and Compatibility	3	0	0	30	70	3
	EC320	Optical Communications and Networks						
	EC221	Optimization Techniques						
Audit-II	AC105	Disaster Management	2	0	0	30	70	0
	AC106	Pedagogy Studies						
	AC107	Stress Management by Yoga						
	AC108	Personality Development through Life Enlightenment Skills						
Lab-II	EC352	Microwave Systems Laboratory-II	0	0	3	50	-	1.5
	EC362	Seminar-II	0	0	3	50		1.5
	EC371	Mini Project with Seminar	0	0	6	50	-	3
TOTAL			14	0	12	300	350	18
SEMESTER-III								
Programme Elective-V	EC321	Radar Signal Processing	3	0	0	30	70	3
	EC322	Microwave Solid state Devices and Applications						
	EC323	Software Defined Radio						
Open Elective	OE903	Microwave Integrated Circuits	3	0	0	30	70	3
	EC381	Major Project Phase I	0	0	20	100	-	10
TOTAL			6	0	20	160	140	16
SEMESTER-IV								
	EC382	Major Project Phase II	0	0	32	-	200	16
GRAND TOTAL								68

M.E. ECE (Embedded Systems and VLSI design)

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	EC401	Analog and Digital CMOS VLSI Design	3	0	0	30	70	3
Core-II	EC402	Microcontrollers and Programmable Digital Signal Processor	3	0	0	30	70	3
Programme Elective-I	EC111	Advanced Computer Architecture	3	0	0	30	70	3
	EC411	CPLD and FPGA Architectures						
Programme Elective-II	EC412	Satellite Navigation System	3	0	0	30	70	3
	EC413	System on Chip Design						
Audit-I	AC101	English for Research Paper Writing	2	0	0	30	70	0
	AC102	Sanskrit for Technical Knowledge						
	AC103	Value Education						
	AC104	Constitution of India						
Lab-I	EC451	Programmable Controllers and CMOS VLSI Design Laboratory	0	0	3	50	-	1.5
	EC461	Seminar-I	0	0	3	50	-	1.5
Core	EC100	Research Methodology in ECE	3	0	0	30	70	3
TOTAL			17	0	6	280	420	18
SEMESTER-II								
Core-III	EC103	VLSI Design Verification and Testing	3	0	0	30	70	3
Core-IV	EC403	Embedded Systems and Real Time Operating Systems	3	0	0	30	70	3
Programme Elective-III	EC414	VLSI Physical Design	3	0	0	30	70	3
	EC116	Internet of Things						
Programme Elective-IV	EC415	VLSI Technology	3	0	0	30	70	3
Audit-II	AC105	Disaster Management	2	0	0	30	70	0
	AC106	Pedagogy Studies						
	AC107	Stress Management by Yoga						
	AC108	Personality Development through Life Enlightenment Skills						
Lab-II	EC452	VLSI Design Verification and RTOS Laboratory	0	0	3	50	-	1.5
	EC462	Seminar-II	0	0	3	50	-	1.5
	EC471	Mini Project with Seminar	0	0	6	50	-	3
TOTAL			14	0	12	300	350	18
SEMESTER-III								
Programme Elective-V	EC119	Analog and Mixed Signal IC Design	3	0	0	30	70	3
	EC118	Low Power VLSI Design						
Open Elective	OE904	Principles of Embedded Systems and VLSI Design	3	0	0	30	70	3
	EC481	Major Project Phase I	0	0	20	100	-	10
TOTAL			6	0	20	160	140	16
SEMESTER-IV								
	EC382	Major Project Phase II	0	0	32	-	200	16
GRAND TOTAL								68

CIE : Continuous Internal Evaluation SEE : Semester End Examination

DIGITAL SYSTEMS (DS)

SEMESTER-I

VLSI DESIGN AND TECHNOLOGY

EC 101

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To learn the basics of MOS Circuits, its process and understand the operation of MOS devices.*
2.	*To impart in-depth knowledge on digital logic design*
3.	*To understand and design the High-speed CMOS logic circuits and acquaint the students with the fundamental concepts of memory and interconnects*

Outcomes: *At the end of this course, students will be able to:*

1.	*Able to understand the fabrication process of IC technology*
2.	*Able to analysis of the operation of MOS transistor*
3.	*Able to design layout of the logic function*
4.	*Student can able to design Adders, Multipliers and memories etc.*
5.	*Getting the idea of design approach*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Review of MOSFET: MOS operation and CMOS process flow, MOS Threshold voltage, Sub threshold conduction. MOSFETI-V characteristics: Long and short channel effects, MOSFET capacitances, lumped and distributed RC model for interconnects, transmission lines, CMOS inverter: Static characteristics, power consumption, dynamic behavior, buffer design. Design rules, Layouts and stick diagram.
UNIT – II
Combinational logic: Transistor sizing in static CMOS logic gates, static CMOS logic gate sizing considering method of logical effort, dynamic logic, pass-transistor logic and Transmission Gate logic. Sequential logic: Static latches and flip-flops (FFs), dynamic latches and FFs, sense-amplifier based FFs, NORA-CMOS, Schmitt trigger circuit.
UNIT – III
High Speed CMOS Logic Design: Switching Time Analysis, Detailed Load capacitance Calculation, Improving Delay calculation with input slope, Gate sizing for optimal path Delay,

Optimizing paths with Logical Effort. Scaling MOS Transistors.
UNIT – IV
Data path Design: Adder, Multiplier, Barrel Shifter, Logarithmic Shifter, Semiconductor Memory Design: Core Memory structure, MOS Decoder, Static RAM cell Design and Content-Addressable Memories (CAM).
UNIT – V
Interconnect Design: Introduction, Interconnect RC Delays, Buffer Insertion very long wires, Interconnect coupling capacitance: Components of Coupling capacitance, Coupling effects on Delay, Crosstalk, Interconnect Inductance. Timing issues: Timing fundamentals, clock distribution and jitter.

References:

1	David A Hodges, Horace G Jackson ResveASaleg "*Analysis and Design of Digital Integrated circuits*" The McGraw Hill Companies 3rd edition, 2006
2	Jan M Rabaey, A Chandrakasan, Borvioje N "*Digital Integrated Circuits Design Perspective*" PHI2nd edition, 2005.
3	Neil H E Weste, David Harris, Ayan Banerjee "*CMOS VLSI Design a circuit's and system perspective*" Pearson 3nd Edition 2009.
4	Wayne Wolf, "*Modern VLSI Design*" 3rd ed., 1997, Pearson Education

MICROCONTROLLER ARCHITECTURE

EC102

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To study the architecture and pin out of 8051 and understand the instructions and program the 8051.*
2.	*To communicate serially with the devices and understand the importance of different peripheral devices & their interfacing to 8051*
3.	*To gain knowledge on ARM processors and basic architecture.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Gain comprehensive knowledge about architecture and addressing modes of 8051.*
2.	*Write assembly language program in 8051 for various applications.*
3.	*Program interrupts and communicate 8051 serially external devices*
4.	*Able to analyze and design real world applications and interface peripheral devices to the microprocessor.*
5.	*Explain basic concepts of ARM processors.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

8051 Architecture and Programming:
Inside the 8051, Introduction to 8051 Assembly0 Programming, Assembly and Running an 8051 Program, The Program Counter and ROM space in the 8051, 8051 Data types and Directives, 8051 Flag bits and PSW register, 8051 Register banks and Stack, Loop and Jump instructions, Call instructions.

UNIT – II

8051 Programming and Addressing modes:
8051 I/O programming, I/O bit manipulation programming, Immediate and Register addressing modes, Accessing memory using various addressing modes, Bit addresses for I/O and RAM, Extra 128-byte on chip RAM in 8052, Arithmetic instructions, Signed number concepts and Arithmetic operations, Logic and Compare instructions, Rotate instruction and Data serialization, BCD, ASCII and other application programs.

UNIT – III

Timer, Serial communication and Interrupt programming: Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C, Basics of Serial Communication, 8051

Connection to RS232, 8051 Serial Port programming in Assembly, 8051 Interrupts, Programming Timer Interrupts, Programming External Hardware interrupts, Programming the Serial Communication Interrupt.
UNIT – IV
LCD interfacing, Keyboard interfacing, Parallel and Serial ADC, DAC Interfacing, Relays and Optoisolators, Stepper Motor interfacing, DC Motor interfacing and PWM
UNIT – V
ARM Processors fundamentals: Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts and the Vector Table, Core Extensions, Architecture Revision, ARM Processor families.

References:

1	Mohammad Ali Mazidi, Rolin D McKinley, Janice G Mazidi, "*The 8051 Microcontroller and Embedded Systems"*, Second Edition, Prentice Hall
2	Andrew N.Sloss, Domnic Symes, Chris Wright, "*ARM system developers guide*", Elsevier publications.
3	Kenneth Ayala, "*The 8051 microcontroller"*, third edition, Penram international publications

PROGRAM SPECIFIC ELECTIVE - I

ADVANCED COMPUTER ARCHITECTURE

EC 111

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To Design Basic Data Path Unit (DPU) and Control Unit (CU) and to Familiarize with Parallel Processing Architectures*
2. *To Develop OpenCL Programming Environment and developing Kernel Programming*
3. *To Know Heterogeneous Architectures*

Outcomes: *At the end of this course, students will be able to*

1. *To Realize Data Path Unit (DPU) and Control Unit (CU)*
2. *To Analyze the Performance of Multi-Core Architectures*
3. *To Demonstrate OpenCL Programs for real time applications*
4. *To Implement Kernels for Heterogeneous Architectures in OpenCL*
5. *To List and Describe the Challenges in Advanced Parallel Processing Architectures*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Processor Design:

CPU Design – CPU Organization – Data Path Design: Fixed Point Booth's Multiplier, Restoring Division Unit and Non-Restoring Division Unit.

Memory Hierarchy **–** Virtual Memory – Cache Memory

Control Unit Design – Hardwired Control Unit Design of Basic CPU.

Case Studies: Verilog HDL Implementation of Booth's Multiplication, Restoring and Non-Restoring Division and Hardwired Control Unit Realization of Basic CPU

UNIT – II

Multi Core Architectures:

RISC, CISC, Flynn's Classification, Instruction Level Parallelism: Super Scalar, VLIW and EPIC architectures. Scalable, Multithreaded and Dataflow Architectures: Principles of Multithreading, Fine-Grain Multithreading, Scalable and Multithreaded Architectures and Dataflow and Hybrid Architectures.

Case Studies: Threads and OpenMP

UNIT – III
Accelerated Architectures: GPU: nVidia and AMD Architecture – GPU memory and Scheduling, Parallel Programming Development and Environment: MPI – CUDA – OpenCL: Introduction, Platform and Devices, Execution Environment and Memory Model *Case Studies:* OpenCL programming
UNIT – IV
Low Power Architectures: System on Chip Architectures – Raspberry-Pi, nVidia SoC – Basics of Kernels: Kernels, Work-items, Work-groups and Execution Domain, OpenCL Synchronization *Case Studies:* Programming on Raspberry Pi.
UNIT – V
Advances in Parallel Processor Architectures: *Hybrid Architectures* – Issues and Challenges in Heterogeneous Computing, Schedulers, Process Synchronization and Programming *Virtualization* – Processor and Memory *Case Studies:* Hybrid Programming using CPU and GPU

References:

1	Hayes John P, "*Computer Architecture and organization,"* 3rd edition, McGraw Hill Education, 1998.
2	William Stallings, *"Computer Organization and Architecture: Designing for Performance",* 8th edition, PHI, 2007.
3	Hwang and Naresh Jotwani, *"Advanced Computer Architecture: Parallelism, Scalability and Programmability,*" McGraw Hill Education, 2017.
4	Benedict Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry and Dana Schaa, *"Heterogeneous Computing with OpenCL,"* Morgan Kaufmann Publications, 2011.

FIELD PROGRAMMABLE GATE ARRAYS

EC 112

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*Describe Application Specific IC (ASIC) fundamentals and study various types of FPGAs Architectures.*
2.	*Design a digital circuit and implement using FPGA and understand Interconnection, Placement and Routing schemes.*
3.	*Learn Verification and testing schemes.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Identify various types of FPGAs Architectures.*
2.	*Design FPGA based system for engineering applications*
3.	*Implement prototype digital systems using design tools.*
4.	*Calculation of interconnection delays of Application Specific IC.*
5.	*Apply simulators and testing prototype design systems.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
*Introduction to ASIC's***:** Types of ASIC's, ASIC design flow, Economies of ASIC's, Programmable ASIC's: Introduction to CPLD and FPGA. Programming technologies, FPGA Design cycle, Implementation tools: Simulation and synthesis, Applications of FPGAs.
UNIT – II
*Commercially available CPLD's and class of FPGA's***:** FPGA logic cell for XILINX, ALTERA and ACTEL ACT, Technology trends, Programmable I/O blocks, FPGA interconnect: Routing resources, FPGA design flow, Dedicated Specialised components of FPGAs.
UNIT – III
FPGA physical design: CAD tools, FPGA Partitioning, Partitioning methods. Floor planning: Goals and objectives, I/O, Power and clock planning, Low-level design entry.
UNIT – IV
*Placement***:** Goals and objectives, Placement algorithms: Min-cut based placement, Iterative Improvement and simulated annealing. *Routing:* Global routing: Goals and objectives, Global routing methods, Back-annotation. Elmore's constant, RC delay and parasitic capacitance, *Detailed Routing:* Goals and objectives, Channel density, Segmented channel routing, Maze

routing, Clock and power routing, Circuit extraction and DRC.
UNIT – V
Verification and Testing: Verification: Logic simulation, Design validation, Timing verification. Testing concepts: Failures, Mechanism and faults, Fault coverage. *Design Applications:* General Design issues, Counter Examples, A Fast DMA controller, Designing adders and accumulators with Xilinx Architecture.

References:

1	Michael John Sebastian Smith, *"Application Specific Integrated Circuits"*, Pearson Education Asia, 3rd edition 2001
2	Pak and Chan, Samiha Mourad, "*Digital Design using Field Programmable Gate Arrays"*, Pearson Education, 1st edition, 2009.
3	S. Trimberger, Edr, "*Field Programmable Gate Array Technology"*, Kluwer Academic Publications, 1994.
4	John V. Oldfield, Richard C Dore, "*Field Programmable Gate Arrays"*, Wiley Publications.

PROGRAM SPECIFIC ELECTIVE - II

VLSI TESTING

EC 113

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To understand faults, fault models in digital systems and understand fault diagnosis*
2.	*To understand various test generation methods for combinational and sequential systems*
3.	*To understand various DFT architectures and study about various test algorithms*

Outcomes: *At the end of this course, students will be able to:*

1.	*Design fault models and fault simulation methods*
2.	*Generate tests for the given faulty circuits*
3.	*Test various combinational circuits and sequential circuits*
4.	*Test PLAs and develop algorithms*
5.	*Diagnose a system*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to testing : Faults in digital circuits, Modeling of faults, Logical Fault Models, Fault detection, Fault location, Fault dominance, Logic Simulation, Types of simulation, Delay models, Gate level Event-driven simulation
UNIT – II :
*Test Generation for Combinational and Sequential circuits***:** Test generation for combinational logic circuits, Testable combinational logic circuit design, Test generation for sequential circuits, and design of testable sequential circuits.
UNIT – III
Design for Testability: Design for Testability, Ad-hoc design, Generic scan-based design, Classical scan-based design, System level DFT approaches.
UNIT – IV
Self-Test and test algorithms: Built-In Self-Test, Test pattern generation for BIST, BIST Architectures, test generation algorithms for PLAs, testable PLA designs- concurrent and parity testable PLAs

UNIT – V
Fault Diagnosis: Logic Level Diagnosis, Diagnosis by UUT reduction, Fault Diagnosis for Combinational Circuits, expert system for diagnosis, Effect-cause analysis, System Level Diagnosis.

References:

1	M. Abramovici, M.A. Breuer and A.D. Friedman, *"Digital Systems and Testable Design"*, Jaico Publishing House, 2002.
2	M.L. Bushnell and V.D. Agrawal, *"Essentials of Electronic Testing for Digital, Memory and Mixed -Signal VLSI Circuits"*, Kluwer Academic Publishers, 2002.
3	P.K. Lala, *"Digital Circuit Testing and Testability"*, Academic Press, 2002.
4	A.L. Crouch, *"Design Test for Digital IC's and Embedded Core Systems"*, Prentice Hall International, 2002

WIRELESS AND MOBILE COMMUNICATIONS

EC 114

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *An overview of key wireless technologies: Various generations of mobile communications for voice and data, cordless, paging, fixed and mobile broadband wireless systems, and beyond*
2. *Wireless system design fundamentals: channel assignment, handoffs, interference, frequency reuse, capacity planning, large-scale fading, and Outdoor, Indoor propagation models and Path loss, small-scale fading, multipath, reflection, diffraction, scattering and Various statistical models for small-scale fading study*
3. *Various Diversity techniques, Equalizers used in communication receivers, Multiple Access techniques and their applications in wireless networks*

Outcomes: *At the end of this course, students will be able to:*

1. *Develop design models for cellular systems.*
2. *Analyze the various Large-scale fading effects in designing propagation models for Mobile communications in Outdoor environments.*
3. *Analyze the various types of Small-scale fading, measurement techniques, Parameters of multi-path radio and Statistical models.*
4. *Understand Various Diversity techniques and Equalizers used in communication receivers.*
5. *Develop the design models for various multiple access techniques and understand their spectral efficiencies.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction to Wireless Communication Systems and the Cellular Concept
Evolution of Mobile Radio Communications, Examples of Wireless Communication Systems, Overview of 1G,2G, 2.5 G,3 G, 4G and 5G Cellular networks.
The Cellular Concept: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Improving Coverage and Capacity in cellular systems.

UNIT – II
Mobile Radio Propagation: Large-Scale Path Loss: Introduction to Radio wave propagation, Free space propagation model, Relating Power to Electric Field, the three basic propagation mechanisms- Reflection, Ground Reflection (Two Ray) model, Diffraction, Scattering. *Outdoor propagation models:* Longley-Rice model, Okumura model, Hata model, PCS Extension to Hata model, Walfisch and Bertoni Model, Wideband PCS Microcell model. *Indoor propagation models:* Partition losses (same floor), Partition losses between floors, Log-distance path loss model, Ericsson multiple breakpoint model, Attenuation factor model, and Signal penetration into buildings.
UNIT – III
Mobile Radio Propagation: Small Fading and Multipath: Small scale multipath propagation, Factors influencing small scale fading, Doppler shift, Small scale multipath Measurements-Direct RF Pulse System, Spread Spectrum Sliding correlator Channel Sounding, Frequency Domain Channels Sounding, Parameters of Mobile multipath channels, Types of Small Scale Fading, Statistical models for multipath Fading Channels-Clarke's model for flat fading, spectral shape due to Doppler, Level Crossings and Fading Statistics, Two-ray Rayleigh Fading model.
UNIT – IV
Equalization and Diversity: Introduction, Fundamentals of Equalization, Training a Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Nonlinear Equalization-Decision Feedback Equalization (DFE), Maximum Likelihood Sequence Estimation (MLSE) Equalizer, Algorithms for adaptive equalization *Diversity Techniques*: Practical Space Diversity Considerations, Selection Diversity, Scanning Diversity, Maximal Ratio Combining, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver.
UNIT – V
Multiple Access Techniques for Wireless Communications: FDMA, TDMA, Spread Spectrum Multiple Access- FHMA and CDMA, SDMA, Spectral efficiency analysis for Multiple Access Technologies: FDMA, TDMA and CDMA Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas.

References:

1	Theodore, S. Rappaport, *"Wireless Communications, Principles and Practice"*, 2nd Ed.,2002, PHI publication.
2	2. Andrea Goldsmith, *"Wireless Communications*", 2005, Cambridge University Press.
3	Kaveh pah Laven and P.Krishna Murthy, *"Principles of Wireless networks"*, 2002,PE.
4	P.Nicopolitidis, M.S.Obaidat, G.I.Papadimitriou, A.S.Pomportsis, *"Wireless Networks"*, 200, John Wiley & Sons Pte Ltd.
5	Ashok Raj, *"Wireless Communication*", First Edition, 2014, Khanna Publishers.

RESEARCH METHODOLOGIES IN ECE

EC 100

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To know the motivation on research philosophy and processes in general.
2. To be able to formulate the problem statement and prepare research plan for the problem under investigation through literature.
3. To be able to apply various techniques for data analysis and patenting

Outcomes:

1. Students able to understand research methodology and problems
2. Able to define the techniques involved in defining problem
3. Able to Developing a Research plan and research set up
4. Able to analyze the collection of data and statistical analysis
5. Able to have knowledge on writing the report and patenting

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Objectives and Types of research: Objectives and Motivation of research- types of research-Research approaches – Significance of Research-Research Methods versus Methodology-Research and Scientific method- Importance of research methodology – Research process-criteria of good research- Problems encountered by Researchers in India-benefits to society in general.
UNIT – II
Research formulation: Defining and formulating the research problem, selecting the problem, importance of literature review in define a problem, literature review, primary and secondary sources, reviews, monograms, patents, research data bases web as a source, identifying gap areas from literature review and research data bases, devilment of working hypothesis
UNIT – III
Research Design and methods: Meaning of research design - need of research design- features of a good design- important concepts relating to research design- different research designs-Basic Principles of experimental designs- Developing a Research plan-Exploration, descriptions diagnosis and experiment

UNIT – IV
Execution of the research and data collection: Aspect of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis, strategies and tool, data analysis with statistical packages (sigma STAT, SPSS for student test t-test, ANOVA, etc.) hypothesis testing, generalization and interpretation.
UNIT – V
Reporting and thesis writing: Structure and components of scientific reports, types of report, technical report and thesis. Thesis writing-different steps and software tools (word processing) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, illustrations and tables, bibliography, referencing and footnotes. Use of visual aids. *Patenting:* The Basics of the Patent System, Patent Law, How to Read a Patent, Protecting Invention and Planning Patent Filing, Preparing Patent Application.

References:

1	C.R.Kothari, "*Research methodology, Methods & technique*", New age international publishers, 2004.
2	R.Ganesan, "*Research Methodology for Engineers*", MJP Publishers: Chennai, 2011.
3	P.Ramdass and A.Wilson Aruni, *"Research and Writing across the disciplines",* MJP Publishers, Chennai 2009
4	Matthew Y Ma, "Fundamentals of Patenting and Licensing for Scientists and Engineers" 2nd Edition 2015

AUDIT COURSE-I
ENGLISH FOR RESEARCH PAPER WRITING

AC 101

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*Understand that how to improve your writing skills and level of readability*
2.	*Understand the nuances of language and vocabulary in writing a Research Paper.*
3.	*Develop the content, structure, format of writing a research paper and produce original research papers without plagiarism*

Outcomes: *At the end of this course, students will be able to:*

1.	*Interpret the nuances of research paper writing.*
2.	*Differentiate the research paper format and citation of sources.*
3.	*To review the research papers and articles in a scientific manner.*
4.	*Avoid plagiarism and be able to develop their writing skills in presenting the research work.*
5.	*Create a research paper and acquire the knowledge of how and where to publish their original research papers*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.
UNIT – II
Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.
UNIT – III
Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.
UNIT – IV
Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing - The final draft and proof reading.
UNIT – V
Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications –

Advantages/Benefits *Presentation Skills:* Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

References:

1	C. R Kothari, Gaurav, Garg, "*Research Methodology Methods and Techniques*", 4/e, New Age International Publishers.
2	Day R, "*How to Write and Publish a Scientific Paper"***,** Cambridge University Press, 2006
3	"*MLA Hand book for writers of Research Papers*", 7/e, East West Press Pvt. Ltd, New Delhi
4	Lauri Rozakis, Schaum's, "*Quick Guide to Writing Great Research Papers"*, Tata McGraw Hills Pvt. Ltd, New Delhi.

SANSKRIT FOR TECHNICAL KNOWLEDGE

AC 102

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *To get a working knowledge in illustrious Sanskrit, the scientific language in the world*
2. *To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects*
3. *To explore the huge knowledge from ancient Indian literature*

Outcomes: *At the end of this course, students will be able to:*

1. *Develop passion towards Sanskrit language*
2. *Decipher the latent engineering principles from Sanskrit literature*
3. *Correlates the technological concepts with the ancient Sanskrit history.*
4. *Develop knowledge for the technological progress*
5. *Explore the avenue for research in engineering with aid of Sanskrit*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)
UNIT – II
Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series). The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).
UNIT – III
Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering): Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower- Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)
UNIT – IV
Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vedic

command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.
UNIT – V
Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthi yanthram

References:

1	M Krishnamachariar, "*History of Classical Sanskrit Literature",* TTD Press, 1937.
2	M.R. Kale, "*A Higher Sanskrit Grammar: For the Use of School and College Students*", Motilal Banarsidass Publishers, 2015.
3	Kapail Kapoor, "*Language, Linguistics and Literature: The Indian Perspective",* ISBN-10: 8171880649, 1994.
4	"*Pride of India*", Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5	Shri Rama Verma, "*Vedas the source of ultimate science",* Nag publishers, 2005.

VALUE EDUCATION

AC 103

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Understand the need and importance of Values for self-development and for National development.*
2. *Imbibe good human values and Morals*
3. *Cultivate individual and National character.*

Outcomes: *At the end of this course, students will be able to:*

1. *Gain necessary Knowledge for self-development*
2. *Learn the importance of Human values and their application in day to day professional life.*
3. *Appreciate the need and importance of interpersonal skills for successful career and social life*
4. *Emphasize the role of personal and social responsibility of an individual for all-round growth.*
5. *Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.
UNIT – II
Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.
UNIT – III
Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.
UNIT – IV
Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy

books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.
UNIT – V
Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

References:

1	Chakroborty, S.K., *"Values & Ethics for organizations Theory and practice*", Oxford University Press, New Delhi, 1998.
2	2. Jaya Dayal Goyandaka, "*Srimad Bhagavad Gita with Sanskrit Text*", Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur, 2017.

CONSTITUTION OF INDIA

AC 104

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective*
2. *To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role*
3. *Entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*

Outcomes: *At the end of this course, students will be able to:*

1. *Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.*
2. *Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.*
3. *Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru*
4. *The eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.*
5. *Discuss the passage of the Hindu Code Bill of 1956.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.
UNIT – II
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
UNIT – III
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT – IV
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
UNIT – V
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

1	*"The Constitution of India",* 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, *"Dr. B. R. Ambedkar framing of Indian Constitution",* 1st Edition, 2015.
3	M. P. Jain, "*Indian Constitution Law",* 7th Edn., Lexis Nexis, 2014.
4	D.D. Basu, *"Introduction to the Constitution of India",* Lexis Nexis, 2015.

DIGITAL SYSTEM LABORATORY – I

EC 151

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1. *Design CMOS Digital Circuits*
2. *Develop 8051 programs in Keil Software*
3. *Interface real time devices with 8051*

Outcomes: *At the end of this course, students will be able to:*

1. *Design and Analyze CMOS Digital Circuits*
2. *Model VLSI Interconnects*
3. *Acquaint with Keil Software*
4. *Implement 8051 Programs*
5. *Demonstrate Real Time interfacing with 8051*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

CYCLE-1

VLSI Design and Technology:

1. Design of CMOS Inverter &two input NAND Gate.
2. Design of Half Adder using NAND Gates
3. Design a Full Adder using transmission gate logic.
4. Design a Schmitt trigger circuit using CMOS logic
5. Design of 4-bit Adder using Full Adder.
6. Design a 4bit barrel shifter
7. Design of 4-bit thermometer to Binary Code converter.
8. Design and draw the layout of above Digital Circuits.
9. Analyze a two-level RC interconnect circuit for a step input
10. Analyze a tree level inductive interconnect model circuit

CYCLE– 2:

Part A: Simulation of basic 8051 programs using Keil µvision

1. Data Transfer -Block move, Exchange, Sorting, Finding largest element inan array.
2. Arithmetic Instructions -Addition/subtraction, multiplication and division,square, Cube –(16bits Arithmetic operations –bit addressable).
3. Counters
4. Boolean & Logical Instructions (Bit manipulations)
5. Conditional CALL & RETURN
6. Code conversion: BCD –ASCII; ASCII –Decimal; Decimal –ASCII
7. HEX -Decimal and Decimal –HEX
8. Programs to generate delay, Programs using serial port and on-Chip timer /Counter

Part B: Interfacing Programs Using Keil µvision Software & 8051 µc Development Board

1. Interfacing of LEDs to 8051 microcontrollers
2. 7 – Segment Display
3. LCD
4. Keypad
5. DAC
6. Stepper Motor

SEMINAR – I

EC 161

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Outcomes: At the end of this course, students will be able to**:**

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

SEMESTER-II

VLSI DESIGN VERIFICATION AND TESTING

EC 103

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To Develop Structural, Dataflow and Behavioral Modeling of Verilog HDL.*
2.	*To Know Basics of System Verilog and Familiarize with Object Oriented Programming*
3.	*To Explore Randomization and Threads in System Verilog an also, to Know Test Coverage in System Verilog*

Outcomes: *At the end of this course, students will be able to:*

1.	*To Realize and Verify Combinational and Sequential Circuits in Verilog HDL*
2.	*To Construct User Defined Data Types in System Verilog*
3.	*To Create Object Oriented Programming Environment*
4.	*To Demonstrate Randomization and Coverage Concepts of System Verilog*
5.	*To Propose Efficient Testable Digital Systems in System Verilog*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction to Verilog
Verilog Basics: Modules and Ports, Structural, Data Flow, Behavioral and switch level Modeling, Tasks and Functions, Logic Synthesis, Timing Delays.
Static timing analysis: Setup time & hold time violations, clock skew.

UNIT – II

Introduction to Verification
Verification guidelines: Verification Process, Test bench creation, Significance of Verification, Verilog for verification.
Introduction to System Verilog: Advantages over Verilog, Methodology, Randomization basics, Coverage basics
Data Types: Built-in data types, Fixed and dynamic Arrays, Queues, Associative Arrays, Enumerated data types, Procedural statements, Time values.

UNIT – III

Introduction to Object Oriented Programming (OOP): Communication between the Test bench and DUT, Interface Construct, Stimulus Timing, Interface Driving and Sampling, Programming block basics, System Verilog assertions.

OOP: Object Oriented Programming significance and advantages, classes, objects, object handles, methods, Static and Global Variables, using one class inside another class, Dynamic objects, copying objects, Public Vs Local and Building a test bench, Tasks and Functions.
UNIT – IV
Verification using System Verilog *Randomization:* Significance, randomization in system Verilog, Constraint randomization, atomic stimulus generation, random number generation, constraint tips and techniques. *Threads:* Threads, inter process communication, Events, Semaphores, Mailboxes virtual methods, Copying an Object, Inheritance, Abstract Classes and Pure Virtual Methods. Case study using Verification Machine.
UNIT – V
Advanced System Verilog: Callbacks, Parameterized Classes, Static and Singleton Classes *Coverage:* Introduction, Coverage Types, Functional Coverage Strategies, cover group, defining cover groups in classes, Data sampling, coverage points, Coverage methods, Cross coverage, Case study using Universal Verification Machine (UVM).

References:

1	Ming-Bo Lin., "*Digital System Designs and Practices Using Verilog HDL and FPGAs"*, Wiley India, 2008.
2	Samir Palnitkar, "*Verilog HDL: A Guide to Digital Design and Synthesis"*, Pearson Education, 2005.
3	Christ Spear and Greg Tumbush, "*System Verilog for Verification"*, 3rd ed., Springer, 2012.

DESIGN OF FAULT TOLERANT AND TESTABLE SYSTEMS

EC 104

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To know about Reliability Concepts and basic concepts of self-checking circuits,*
2. *To learn about Basic concepts of Testability, ATG and design of testability*
3. *To know the use of control and Syndrome Testable Designs*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand reliability of various architectures*
2. *Design fail safe circuits*
3. *Implement algorithms for test generation for combinational circuits*
4. *Use control logic for DFT*
5. *Implement BIST architectures*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Fault Tolerant Design: Basic Concepts: Reliability Concepts, Failure & Faults, Reliability and Failure rate, Relation between Reliability and Meantime between failure, Maintainability and Availability, Reliability of series, parallel and Parallel – Series combinational circuits.
Fault Tolerant Design: Basic Concepts – Static, dynamic, hybrid Triple Modular Redundant System, Self-purging redundancy, Siftout redundancy (SMR), 5 MR Re-Configuration techniques, Time redundancy and software redundancy

UNIT – II

Self-Checking Circuits & Fail-Safe Design: Self Checking circuits: Basic concepts of self-checking circuits, Design of Totally self-checking checker, checkers using m out of n codes, Berger code, Low Cost residue code. Fail Safe Design: Strongly fault secure circuits, fail safe design of sequential circuits using partition theory and Berger code, totally self-checking PLA Design.

UNIT – III

ATPG Fundamentals and Design for Testability for Combinational Circuit: Introduction to ATG, ATG for SSFs in combinational circuits- basic algorithms, D and 9V algorithms, ATG for SSFs in sequential circuits using iterative array model

UNIT – IV
Design for testability: Design for Testability for Combinational logic Circuits: Basic concepts of Testability, Controllability and Observability, The Reed Muller's expansion technique, OR-AND-OR Design, Use of control logic and Syndrome Testable Designs
UNIT – V
Built In Self-Test (BIST): BIST concepts, Tests Pattern generation for BIST exhaustive testing, pseudorandom testing, pseudo exhaustive testing, constant weight patterns, Generic offline BIST architecture, Memory Test architecture.

References:

1	Parag K. Lala, "*Fault Tolerant & Fault Testable Hardware Design"*, PHI, 1984.
2	Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, "*Digital SystemsTesting and Testable Design*", Jaico Books
3	Alfred L. Crouch, "*Design for Test for Digital IC's and Embedded Core Systems*", Pearson Education, 2008.
4	Bushnell & Vishwani D.Agarwal, "*Essentials of Electronic Testing"*, Springers.

PROGRAM SPECIFIC ELECTIVE - III

ADVANCED COMMUNICATION AND COMPUTER NETWORKS

EC 115

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Overview of communication computer networks, internet, and foundation of basic networking protocols and detailed study of Data link layer and local area networks*
2. *Study of Routing and Congestion control at the network layer.*
3. *Learn Protocols in Network layer and multicast routing in internetworking and also, analyse of protocols Transport layer, and Application Layer*.

Outcomes: *At the end of this course, students will be able to:*

1. *Understand advanced concepts in Communication Networking.*
2. *Design and develop protocols for Communication Networks.*
3. *Understand the mechanisms in Quality of Service in networking.*
4. *Optimise the Network Design.*
5. *Analyse protocols multicast routing in internetworking.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Data Communications concepts: Data Communications Model Communication Tasks, Networks and Networking configurations and Internet. *Foundation of Networking Protocols:* 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing.
UNIT – II
Data Link Control protocol: Flow Control, Sliding Window Flow Control, Error control, CRC, ARQ Protocols, Data Link Control, Bit stuffing, HDLC Operation. *Local Area Networks:* LAN Architecture. Topologies, Choice of Topology, Ring and Star Usage, MAC and LLC, Generic MAC Frame Format, Multiple Access Protocols, LAN Addresses and ARP, Ethernet, Hubs, Bridges and Switches.
UNIT – III
Switching and multiplexing: Circuit Switching networks and Packet Switching: Packet Switching Principles, Datagram and Virtual Circuit switching, *Wide Area Routing:* Path Selection Algorithms - Dijkstra's Algorithm, Bellman-Ford Algorithm, Packet Flooding and Deflection Routing Algorithm. Congestion Control at the

Network Layer.
UNIT – IV
*Network layer: Internet Protocol:*Internetworking, IPv4, IPv6 Transition from IPv4 to IPv6 *Multicast Routing and Protocols:* Basic Definitions and Techniques, Internet Group Management Protocol (IGMP).
UNIT – V
Transport and End-to-End Protocols: User Datagram Protocol (UDP), Transmission Control Protocol (TCP), TCP Congestion Control. *Application Layer:* The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, Domain Name System (DNS).

References:

1	William Stallings, "*Data and Computer Communications*", Eigth Edition, Pearson Prentice Hall, 2007.
2	Behrouz A. Forouzan, *"Data Communications and Networking*", Fourth Edition, Tata Mc Graw Hill, 2007.
3	Douglas E. Comer, "*Internetworking with TCP/IP*", Pearson Education, 6th Edition.
4	Prakash and C.gupta "*Data communications and computer networks*" second Edition, Pearson, PHI learning, 2014.

INTERNET OF THINGS

EC 116

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To understand Smart Objects and IoT Architectures and learn about various IOT-related protocols*
2. *To build simple IoT Systems using Arduino and Raspberry Pi*
3. *To understand data analytics, cloud in the context of IoT and to develop IoT infrastructure for popular applications*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand the concepts of Internet of Things*
2. *Analyze basic protocols in wireless sensor network*
3. *Design IoT applications in different domain*
4. *Able to analyze design performance*
5. *Implement basic IoT applications on embedded platform*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Fundamentals of IoT: Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects.
UNIT – II
IoT Protocols IoT access technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.
UNIT – III
*Design and development design methodology***:** Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

UNIT – IV
Data analytics and supporting services: Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG Developing.
UNIT – V
*Case studies/industrial applications***:** Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

References:

1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, *"IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things*", Cisco Press, 2017
2	Vijay Madisetti, Arshdeep Bahga, *"Internet of Things: A Hands-On Approach*"

PROGRAM SPECIFIC ELECTIVE - IV

DIGITAL DESIGN AND PLDS

EC 117

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To simplify the multiple output functions and design of PLDs*
2. *To know the analysis and synthesis of Synchronous and Asynchronous sequential machines*
3. *To understand the Algorithmic State Machine chart for digital designs and minimize the state machines using merger diagrams*

Outcomes: *At the end of this course, students will be able to:*

1. *Minimize of multiple output functions and design using PLDs*
2. *Analyze and synthesis of Synchronous sequential machines*
3. *Analyze and synthesis of Asynchronous sequential machines*
4. *Draw Algorithmic State Machine chart for digital circuits*
5. *Simplify the states using state reduction techniques and merger diagrams*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Tabulation and K-Map minimization method to simplify the multi outputs. Algebraic methods for Determining Prime implicants, Essential implicants. Top- down Modular Combination Logic Design, Computer-aided design of Logic circuits. Combinational circuit Design with Programmable logic Devices (PLDs).
UNIT – II
Introduction to sequential circuits, Sequential circuit model & classification state table and state diagram. Memory devices: Latches and Flip-Flops, excitation table, characteristic equations, conversion of flip-flops and state diagram. Sequential circuits: Mealy and Moore models.
UNIT – III
Analysis and Synthesis of Synchronous sequential circuits. Synchronous Sequential Circuit Models. Sequential Circuit Analysis. One hot finite state machine design method. Finite State controllers. Algorithmic State Machine (ASM) diagram.
UNIT – IV
Analysis and Synthesis of Asynchronous sequential circuits: Analysis of Pulse mode and

fundamental mode circuits. Synthesis of Pulse mode circuits. Introduction to Races, Cycles and Hazards.
UNIT – V
Simplification of Sequential circuits. Redundant states, State reduction in completely and incompletely specified circuits. Compatible and Incompatible states. Merger diagrams, optimal state assignment methods.

References:

1	CD Victor, P. Nelson, H Troy Nagle, Bill D. Carrol and J David Irwin. *"Digital Logic Circuit Analysis and Design"*, PHI, 1996.
2	ZviKohavi, "*Switching and Finite Automata Theory"*, TMH, 2001.
3	Parag K. Lala, *"Digital System Design using Programmable Logic Devices",* 2003, BSP

LOW POWER VLSI DESIGN

EC 118

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To study the sources of power dissipation and low power design techniques with voltage scaling and capacitance minimization approaches*
2. *To study various low power arithmetic units and the design of low power multipliers*
3. *To study To study about low power memory technologies*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand various power components*
2. *Understand and design low power memories*
3. *Understand and use mathematical models for power analysis in CMOS circuits*
4. *Design low power architectures*
5. *Understand and design multipliers*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Fundamentals: Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.
UNIT – II
*Low-Power Design Approaches***:** Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance Minimization Approaches: System Level Measures and Circuit Level Measures.
UNIT – III
*Low-Voltage Low-Power Adders***:** Introduction, Standard Adder Cells, CMOS Adder Architectures – Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Low-Power Design Techniques–Trends of Technology and Power Supply Voltage, Low-Voltage Low-Power Logic Styles

UNIT – IV
Low-Voltage Low-Power Multipliers: Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh-Wooley Multiplier, Booth Multiplier and Introduction to Wallace Tree Multiplier.
UNIT – V
*Low-Voltage Low-Power Memories***:** Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Pre-charge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM.

References:

1	Sung-Mo Kang, Yusuf Leblebici, *"CMOS Digital Integrated Circuits – Analysis and Design"*, TMH, 2011.
2	Ming-BO Lin, "*Introduction to VLSI Systems: A Logic, Circuit and System Perspective",* CRC Press, 2011
3	Anantha Chandrakasan, *"Low Power CMOS Design*", IEEE Press/Wiley International, 1998
4	Kaushik Roy, Sharat C. Prasad, *"Low Power CMOS VLSI Circuit Design*", John Wiley & Sons,2000.
5	Gary K. Yeap, "*Practical Low Power Digital VLSI Design*", Kluwer Academic Press, 2002.

AUDIT COURSE –II
DISASTER MANAGEMENT

AC 105

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters*
2.	*To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters*
3.	*To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Learn to demonstrate a critical understanding of key concepts in disaster risk reduction*
2.	*Humanitarian response*
3.	*Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.*
4.	*Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.*
5.	*Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT – II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT – III
Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics
UNIT – IV
Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.
UNIT – V
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

References:

1	R. Nishith, Singh AK, *"Disaster Management in India: Perspectives, issues and strategies"*, New Royal Book Company.
2	Sahni, Pardeep (Eds.), *"Disaster Mitigation Experiences and Reflections"*, PHI, New Delhi.
3	Goel S. L., *"Disaster Administration and Management Text and Case Studies",* Deep & Deep Publication Pvt. Ltd., New Delhi.

PEDAGOGY STUDIES

AC 106

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *To present the basic concepts of design and policies of pedagogy studies.*
2. *To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices and familiarize various theories of learning and their connection to teaching practice.*
3. *To create awareness about the practices followed by DFID, other agencies and other researchers and provide understanding of critical evidence gaps that guides the professional development*

Outcomes: *At the end of this course, students will be able to:*

1. *Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.*
2. *Examine the effectiveness of pedagogical practices.*
3. *Understand the concept, characteristics and types of educational research and perspectives of research.*
4. *Describe the role of classroom practices, curriculum and barriers to learning.*
5. *Understand Research gaps and learn the future directions.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT – II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT – III

*Evidence on the Effectiveness of Pedagogical Practices***:** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT – IV
Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.
UNIT – V
Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

References:

1	Ackers J, Hardman F, *"Classroom Interaction in Kenyan Primary Schools, Compare*", 31 (2): 245 – 261, 2001.
2	2. Agarwal M, *"Curricular Reform in Schools: The importance of evaluation*", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3	Akyeampong K, "*Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)",* Country Report 1. London: DFID, 2003.
4	Akyeampong K, Lussier K, Pryor J, Westbrook J, *"Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?"* International Journal Educational Development, 33 (3): 272- 282, 2013.
5	Alexander R J, *"Culture and Pedagogy: International Comparisons in Primary Education",* Oxford and Boston: Blackwell, 2001.
6	Chavan M, Read India: *"A mass scale, rapid, learning to read campaign",* 2003

STRESS MANAGEMENT BY YOGA

AC 107

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Creating awareness about different types of stress and the role of yoga in the management of stress.*
2. *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
3. *Prevention of stress related health problems by yoga practice.*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through asanas.*
5. *Improve work performance and efficiency.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.
UNIT – II
Meaning and Definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.
UNIT – III
Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress
UNIT – IV
Asanas - (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.
UNIT – V
Pranayama - Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama. *Meditation Techniques:* Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

References:

1	Janardhan Swami Yogabhyasi Mandal, "*Yogic Asanas for Group Training - Part-I*", , Nagpur.
2	Advaita Ashrama, "*Swami Vivekananda, "Rajayoga or Conquering the Internal Nature",* (Publication Department), Kolkata.
3	Nagendra H.R and Nagaratna R, "*Yoga Perspective in Stress Management",* Swami Vivekananda Yoga Prakashan, Bangalore.

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

AC 108

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Outcomes: *At the end of this course, students will be able to:*

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)
UNIT – II
Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.
UNIT – III
Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48
UNIT – IV
Statements of Basic Knowledge - Shrimad Bhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.
UNIT – V
Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

[PTO]

References:

1	Swami Swarupananda Advaita Ashram "*Srimad Bhagavad Gita",* (Publication Department), Kolkata
2	P.Gopinath, *"Bhartrihari's Three Satakam (Niti-sringar-vairagya*)", Rashtriya Sanskrit Sansthanam, New Delhi

DIGITAL SYSTEM LABORATORY – II

EC 152

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1. *To Develop Structural, Dataflow and Behavioral Modeling of Verilog HDL.*
2. *To Know Basics of System Verilog, Randomization, test Coverage and Familiarize with Object Oriented Programming.*
3. *To know about DFT testability and pattern generation*

Outcomes: *At the end of this course, students will be able to:*

1. *To Realize and Verify Combinational and Sequential Circuits in Verilog HDL*
2. *To Construct User Defined Data Types in System Verilog and Create Object Oriented Programming Environment*
3. *To Demonstrate Randomization, Coverage Concepts of System Verilog and Propose Efficient Testable Digital Systems in System Verilog*
4. *To design and generate simple and complex test patterns*
5. *To perform insertion testing*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

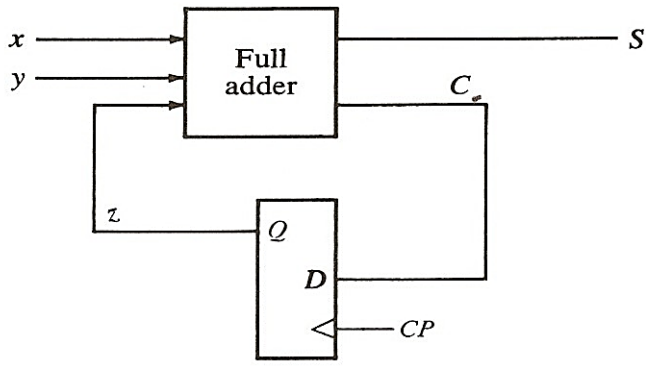
Row wise cumulative percentage weightage should be equal to 1.0.

CYCLE -1

1. Implement a 4-bit pseudo-random Binary sequence generator using a linear feedback shift register with test bench?
2. Implement a 8-bit register with shift left and shift right modes of operation and test the logic with help of test bench?
3. Write Verilog program for cooking-gas delivery with following considerations (with signals request, wait, grant, fine)
   a) Difference between two successive deliveries should be minimum of 15 days.
   b) If user requests before 15 days, wait should be asserted
   c) If user requests when wait is asserted, fine should be asserted
4. Generate Clock signal and write Verilog code for calculating frequency of clock signal?
5. Generate clock signal and write verilog code for skipping two clock cycles at a time and for every two clock cycles the output should be raising edge?
6. Prepare a LUT it contains the Train information such as train number, train time, number of

sleeper classes and number of AC classes. Write a verilog code When user select the Train number the output should display the train information from the prepared LUT?

7. Write SV code for
   a. Class creation c Accessing class properties and methods
   b. Class instance and object Creation d. Class Constructors
8. Write a SV code demonstrating access to static class properties and methods .
9. Write a SV code for
   a. Parent class properties accessed using child class handle.
   b. Parent class method is *overridden* in the child class.
10. Write a system Verilog code to show the usage of *local* keyword and *protected* keyword within and outside a class.
11. Write a SV codes for
    a. Creating abstract classes
    b. Accessing Static class member using class resolution operator
12. Define a base class with Half Adder as a Function.
    a. Write the extended class for Full adder using the base class.
    b. Write a module defining the functionality for 4 bit Ripple carry adder.
13. Define a parent class with a 32 bit protected parameter ***tmp_addr***
    1. Write a child class containing
       i. A constructor to initialize the parameter "***tmp_addr***".
       ii. A function to increment the parameter "***tmp_addr***".
    2. Write a module showcasing the usage of protected variable "***tmp_addr***" after incrementing its address.
14. Define a base class with Full Adder as a Function.
    a. Write the extended classes for D Flipflop.
    b. Write a module defining the functionality for the following circuit.



15. Write constraint to create four random numbers **a, b, c, d**.
    1. "**a**" should be less than 5000 and greater than 100, and should not be divisible by 2
    2. "**b**" should be less than 5,000 and should be divisible by 5
    3. "**c**" should be in the range of 1 to 5 and include the expression [(a-b) : (a+b))]
    4. "**d**" should be greater than all a, b and c.

16. Write a SV code for
    a. covergroup
    b. coverpoint
    c. cross
    d. bin

CYCLE-2

List of assignments

1. Fault models and test patterns
2. Automatic test pattern generation
3. Full DFT flow and ATPG setup
4. Fault locations, Test patterns and pattern generation
5. Fault models
6. Design Rule checks and test coverage

DFT experiments

1. Basic Scan Test by Scan Flip-Flops/Scan Cells
2. Test Patterns and Test Patterns Generation
3. Scan Insertion Using Tessent Scan.
4. ATPG basic scan patterns Using Tessent Fast Scan.
5. Configuring Scan Chains.
6. Advanced Fault Models and Complex Pattern Generation.

SEMINAR – II

EC 162

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Outcomes: At the end of this course, students will be able to**:**

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

5. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
6. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
7. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
8. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

MINI PROJECT WITH SEMINAR

EC 171

Instruction: 6 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 3

Outcomes: *At the end of this course, students will be able to:*

1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained
5. Write the documentation in standard format

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter-disciplinary/ industry relevance.
- The students can select a mathematical modeling based/Experimental investigations or Numerical modeling
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference

Departmental committee: Supervisor and a minimum of two faculty members

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

SEMESTER – III

PROGRAM SPECIFIC ELECTIVE - V

ANALOG AND MIXED SIGNAL IC DESIGN

EC 119

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To Design Basic Building Blocks of Opamp: Current Mirror, Single Stage Amplifiers*
2. *To Design and Analyze Two-Stage Opamp and familiarize with Folded Cascade Opamps*
3. *To Know Applications of Opamps and learn Data Converters and Phased Locked Loops (PLL)*

Outcomes: *At the end of this course, students will be able to:*

1. *To Develop Mathematical Modeling of Building Blocks of Opamps*
2. *To Design and Simulate Two-Stage Opamp for the Given Specifications*
3. *To Analyze the Performance of Operational Trans-Conductance Amplifier.*
4. *To Develop Switched Capacitor Circuits*
5. *To Outline the Principle of Operation of Over-Sampling Rate A/D and D/A Converters*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Building Blocks of Opamp:
MOS Transistor – Nanometer Transistor and its model – body effect, Channel Length Modulation and short channel effects – velocity saturation, sub-threshold conduction, threshold voltage control, drain induced barrier lowering, gate induced drain leakage, Complete MOS Transistor Model and large and small signal models of BJTs and MOSFETs.
Current Mirrors and Single Stage Amplifiers – Simple CMOS current mirror, common source amplifier, source follower, common gate amplifier, cascode amplifiers. Source de-generated current mirrors, cascode current mirror, cascode gain stage and MOS differential pair and gain stage.
Biasing and References – Analog IC biasing, establishing constant trans-conductance and band-gap reference – Positive and negative temperature coefficient basics and circuits.

UNIT – II

Basic Opamp and Compensation: Basic two-stage MOS Operational amplifier, characteristic

parameters, compensation, design and analysis of two-stage MOS opamp with given specifications. Stability and frequency compensation of op-amps.
UNIT – III
Operational Trans-conductance Amplifier (OTA): *Advanced current Mirrors* – Wilson current mirror, Enhanced output-impedance current mirror and gain boosting and wide swing current mirror with enhanced output impedance and bipolar current mirrors – bipolar gain stages. *Single stage Opamp* – Folded-cascade opamp, current mirror opamp, fully differential opamp and common mode feedback circuits.
UNIT – IV
Applications of Opamp *Comparators:* Op-Amp Based Comparators, Charge Injection Errors – Latched Comparators – CMOS and BiCMOS Comparators – Bipolar Comparators. *Switched capacitor circuits:* Basic building blocks; basic operation and analysis, inverting and non-inverting integrators, signal flow diagrams, first order filter. *Sample and hold circuits* - Performance requirements, MOS sample and hold basics, clock feed through problems, S/H using transmission gates, high input impedance S/H circuits, improved S/H circuits from the point of slewing time, clock feed through cancellations.
UNIT – V
Mixed Signal IC Applications: *Data Converters* – Review of Nyquist-Rate A/D and D/A converters, Noise Sources: Flicker, Thermal, Oversampling converters – Over sampling without noise shaping and with noise shaping, system architectures and digital decimation filters. *Phase locked loops* – simple PLL, charge pump PLL and dynamics of PLL. *Practical Issues* – Transistor mismatch, offset and techniques to reduce the analog non-idealities (like auto-zero, chopping, CDS etc) and Basics of Analog Layout

References:

1	Tony Chan Carusone, David Johns and Ken Martin, "*Analog Integrated Circuit Design*", 2nd edition, John Wiley & sons. 2013.
2	Behzad Razavi, "*Design of Analog CMOS Integrated Circuits*", McGraw Hill Companies, 2013.
3	Philip E. Allen and Douglas R. Holberg, "*CMOS Analog Circuit Design*", 2nd edition, Oxford University Press, 2010.

VLSI SIGNAL PROCESSING

EC 120

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To enable the students to learn about the concept of pipelining and parallel processing in VLSI and the students to identify applications for unfolding algorithm*
2. *To make the students to understand the analysis of VLSI system with high speed and low power and equip the students with knowledge of Systolic Design for Space Representations containing Delays*
3. *To make the students to understand the concept of Power Reduction and Estimation techniques in VLSI signal processing*

Outcomes: *At the end of this course, students will be able to:*

1. *Explain parallel and pipelining processing techniques.*
2. *Identify applications for unfolding algorithm*
3. *Analyse Systolic Design for Space Representations containing Delays*
4. *Explain Cook-Toom Algorithm, Fast Convolution algorithm by Inspection method.*
5. *Analyze Power Reduction techniques and Power Estimation techniques*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to DSP: Typical DSP algorithms, DSP algorithms benefits, Representation of DSP algorithms. Pipelining and Parallel Processing: Introduction, Pipelining of FIR Digital filters, Parallel Processing, Pipelining and Parallel Processing for Low Power, Retiming: Introduction – Definitions and Properties – Solving System of Inequalities – Retiming Techniques
UNIT – II
Folding and Unfolding, Folding: Introduction -Folding Transform - Register minimization Techniques – Register minimization in folded architectures – folding of multirate systems, Unfolding: Introduction – An Algorithm for Unfolding – Properties of Unfolding – critical Path, Unfolding and Retiming – Applications of Unfolding
UNIT – III
Systolic Architecture Design: Introduction – Systolic Array Design Methodology – FIR Systolic Arrays – Selection of Scheduling Vector – Matrix Multiplication and 2D Systolic Array Design – Systolic Design for Space Representations contain Delays
UNIT – IV

Fast Convolution: Introduction – Cook-Toom Algorithm – Winogard algorithm – Iterated Convolution – Cyclic Convolution – Design of Fast Convolution algorithm by Inspection
UNIT – V
Low Power Design: Scaling Vs Power Consumption–Power Analysis, Power Reduction techniques – Power Estimation Approaches, Programmable DSP: Evaluation of Programmable Digital Signal Processors, DSP Processors for Mobile and Wireless Communications, Processors for Multimedia Signal Processing

References:

1	Keshab K. Parthi, *"VLSI Digital Signal Processing- System Design and Implementation*", 1998, Wiley Inter Science.
2	Kung S. Y, H. J. While House, T. Kailath, *"VLSI and Modern Signal processing*", 1985, Prentice Hall.
3	Jose E. France, Yannis Tsividis, *"Design of Analog – Digital VLSI Circuits for Telecommunications and Signal Processing",* 1994, Prentice Hall.
4	Medisetti V. K, *"VLSI Digital Signal Processing",* IEEE Press (NY), USA, 1995.

OPEN ELECTIVE

FIELD PROGRAMMABLE GATE ARRAYS ARCHITECTURE

OE 901

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Describe Digital design fundamentals and study various types of FPGAs Architectures.*
2. *Design a digital circuit and implement using FPGA and understand Interconnection, Placement and Routing schemes.*
3. *Learn Verification and testing schemes*

Outcomes: *At the end of this course, students will be able to:*

1. *Identify various types of FPGAs Architectures.*
2. *Design FPGA based system for engineering applications*
3. *implement prototype digital systems using design tools*
4. *Familiarity of HDL design using reconfigurable logic.*
5. *Apply simulators and testing prototype design systems.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Programmable Logic Devices: Revision of Combinational Circuits, PROM, PLA, PAL, Architecture of PAL's applications, programming technologies, programmable logic design methods and tools.
UNIT – II
Commercially available CPLD's and class of FPGA's: FPGA logic cell for XILINX, ALTERA and ACTEL ACT, Technology trends, Programmable I/O blocks, FPGA interconnect: Routing resources, Dedicated Specialised components of FPGAs.
UNIT – III
FPGA physical design: FPGA design flow, FPGA Partitioning, Partitioning methods, Placement algorithms: Min-cut based placement, Iterative Improvement and simulated annealing. Global routing methods, Back-annotation. Elmore's constant, RC delay and parasitic capacitance, Segmented channel routing, Maze routing.
UNIT – IV
Introduction of HDL: Verilog/VHDL Comparisons and Guidelines, Verilog: HDL fundamentals, simulation, and test bench design, Examples of Verilog codes for combinational

and sequential logic, programmable counter, FIFO, multipliers, ALU, Barrel shifter.
UNIT – V
Verification and Testing: Verification: Logic simulation, Design validation, Timing verification. Testing concepts, Failures, Mechanism and faults, Fault coverage. *Design Applications:* General Design issues, Counter Examples, A Fast DMA controller, Designing adders and accumulators with Xilinx Architecture.

References:

1	Pak and Chan, Samiha Mourad, *"Digital Design using Field Programmable Gate Arrays"*, Pearson Education, 1st edition, 2009.
2	S. Trimberger, Edr, *"Field Programmable Gate Array Technology*", Kluwer Academic Publications, 1994.
3	John V. Oldfield, Richard C Dore, *"Field Programmable Gate Arrays*", Wiley Publications.
4	Doug Amos, Austin Lesea, Rene Richter, *"FPGA based prototyping methodology manual"*, Xilinx
5	Bob Zeidman, *"Designing with FPGAs & CPLDs"*, CMP Books.
6	Richard S. Sandige, *"Modern Digital Design"*, MGH, International Editions.

SMART SENSORS

OE 902

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Explain the operation/working of different sensors.*
2. *To get fundamental knowledge of sensors and transducers and their operating principles, for measurement of mechanical parameters.*
3. *To impart interdisciplinary knowledge regarding transducers, pneumatic actuators, hydraulic actuators and explain the operation of pressure, flow, and level transducers in context with applications.*

Outcomes: *At the end of this course, students will be able to:*

1. *After successfully completing the course students will be able to Applications and selection of sensors/transducers for particular Application.*
2. *Describe the various types of sensors including thermal, mechanical, electrical, electromechanical and optical sensors.*
3. *Select appropriate transducers and instrumentation system components for a specific application. Design and development of temperature/ pressure etc measurement systems.*
4. *Select appropriate Switches and final control elements for a specific application.*
5. *Selection of communication protocol and smart sensors for particular application.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Basics of Instrumentation Systems General Configuration and functional description of measuring instruments, static and dynamic characteristics of instruments, errors in instrumentation systems, active and passive transducers and their classification, fundamental standards and units for common physical parameters. Temperature, Flow and Level Sensing Temperature: Resistance temperature Detectors, thermistors, thermocouples and pyrometers.

UNIT – II

Position, Motion, Pressure and Force Sensors, Position and motion sensing: Potentiometers, LVDT, proximity sensors (inductive, capacitive and optical), absolute and incremental optical encoders, piezoelectric accelerometer. Pressure Sensors: LVDT as secondary transducer to measure pressure, Stress, Strain and Force: Strain Gauges and load cell. Level: Ultrasonic, Capacitance probe type, Hydrostatic pressure and Nuclear level detection techniques.

UNIT – III
Actuators and Final Control Elements Pneumatic and hydraulic actuators- Directional control valves, Pressure control valves, Cylinders, Process control valves - Electrical actuators- Mechanical switches, Solid state switches, Solenoids, DC motors, AC motors and Stepper motors.
UNIT – IV
Data Acquisition, Bus Standards and Protocols Multichannel data logging and computer based data acquisition system – RS 232C standard, IEEE 488 bus, I2C bus, HART protocol , Field bus technology - Foundation Field bus and Profibus.
UNIT – V
Semiconductor, MEMS and SMART Sensors Semiconductor temperature sensing – LM75 block diagram, temperature compensated, integrated phototransistor, Magnetic field sensors – Hall effect and magneto-resistive elements (MRE), magneto-transistors, piezoelectric (PZT) sensors and actuators. SMART sensors.

References:

1	W. Bolton; *"Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering"*, Pearson Education; 3rd Edition.
2	William C. Dunn, *"Introduction to Instrumentation, Sensors, and Process Control",* Artech House Sensors Library.
3	David G. Alciatore, Michael B Histand; "*Introduction to Mechatronics and Measurement"*
4	Ernest O. Doebelin, *"Measurement System Application and Design*", Mc-Graw Hill; 5th Edition.

MAJOR PROJECT PHASE - I

EC 181

Instruction: 20 periods per week *Duration of SEE: --*
CIE: 100 marks *SEE: --*
Credits: 10

Outcomes: *At the end of this course, students will be able to:*

1.	*Exposed to self-learning various topics.*
2.	*Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.*
3.	*Learn to write technical reports.*
4.	*Develop oral and written communication skills to present.*
5.	*Defend their work in front of technically qualified audience*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, Osmania University and Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

SEMESTER - IV

MAJOR PROJECT PHASE - II

EC 181

Instruction: 32 periods per week *Duration of SEE: --*
CIE: -- *SEE: 200 marks*
Credits: 16

Outcomes: *At the end of this course, students will be able to:*

1.	*Use different experimental techniques and will be able to use different software/ computational /analytical tools.*
2.	*Design and develop an experimental set up/ equipment/test rig.*
3.	*Conduct tests on existing set ups/equipment's and draw logical conclusions from the results after analysing them.*
4.	*Either work in a research environment or in an industrial environment.*
5.	*Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester - III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head, Osmania University and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS & Head, Osmania University (All together	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce

SYSTEMS AND SIGNAL PROCESSING (SSP)

SEMESTER - 1

ADVANCED DIGITAL SIGNAL PROCESSING

EC 201

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To make students familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors*
2.	*Create efficient realizations for upsampling and downsampling of signals using the poly phase decomposition*
3.	*To introduce some practical aspects of signal processing, and in particular adaptive systems*

Outcomes: *At the end of this course, students will be able to:*

1.	*Design, implementation, analysis and comparison of digital filters for processing of discrete time signals*
2.	*Acquire the basics of multi rate digital signal processing.*
3.	*Comprehend design criteria and modeling adaptive systems and theoretical Performance evaluation*
4.	*Analyze the power spectrum estimation*
5.	*Apply the algorithms for wide area of recent applications.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, and Parallel all pass realization of IIR.
UNIT – II
Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in subband coding.
UNIT – III
Linear prediction & optimum linear filters, stationary random process, forward-backward linear

prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.
UNIT – IV
Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation,Parametric Methods for Power Spectrum Estimation, Minimum- Variance Spectral Estimation, Eigenanalysis Algorithms for Spectrum Estimation.
UNIT – V
Application of DSP & Multi rate DSP, Application to Radar, introduction to wavelets, application to image processing, design of phase shifters, DSP in speech processing & other applications

References:

1	J.G.Proakis and D.G.Manolakis, *"Digital signal processing: Principles, Algorithm and Applications",* 4th Edition, Prentice Hall, 2007.
2	S.Haykin, *"Adaptive Filter Theory",* 4th Edition, Prentice Hall, 2001.

DIGITAL IMAGE AND VIDEO PROCESSING

EC 202

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Beyond the obvious applications in entertainment and scientific visualization, digital images and video have become a central component of net-centered computing, human/computer interfaces, and databases, as well as data analysis for domains such as biometrics, surveillance and remote sensing.*
2. This course offers fundamentals of digital image and video processing and algorithms for most of the work currently underway in this field.
3. *Through this course, students will get a clear impression of the breadth and practical scope of digital image and video processing and develop conceptual understanding which will enable them to undertake further study, research and/or implementation work in this area.*

Outcomes: *At the end of this course, students will be able to:*

1. Describe the fundamentals of image and object recognition video processing and their applications
2. Develop familiarity and implement basic image and video processing algorithms.
3. Select and apply appropriate technique to real problems in image and video analysis.
4. Learn different techniques for image enhancement, video and image recovery
5. Understand techniques for image and video segmentation and techniques for image and video compression

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
*Fundamentals of Image Processing and Image Transforms***:** Basic steps of Image Processing System, Monochrome and color vision models**,** Image acquisition and display, Sampling and Quantization of an image – Basic relationship between pixels Image Transforms: 2 D- Discrete Fourier Transform, Discrete Cosine Transform (DCT), Wavelet Transforms: Continuous Wavelet Transform, Discrete Wavelet Transforms.
UNIT – II
Image Processing Techniques Image Enhancement: Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, smoothing spatial filters, Sharpening spatial

filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering. Laplacian of Gaussian (LOG) filters. *Image Segmentation:* Segmentation concepts, Point, Line and Edge Detection, Thresholding, Region Based segmentation. Hough Transform, boundary detection, chain coding,
UNIT – III
Image Compression: Image compression fundamentals - Coding Redundancy, Spatial and Temporal redundancy, Compression models: Lossy & Lossless, Huffman coding, Arithmetic coding, LZW coding, Run length coding, Bit plane coding, Transform coding, Predictive coding, Wavelet coding, JPEG standards.
UNIT – IV
Basic steps of Video Processing: Analog Video, Digital Video. Principles of color video processing, composite versus component video, Time-Varying Image Formation models Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.
UNIT – V
2-D Motion Estimation: Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding, Contant dependent video coding and Joint shape and texture coding, MPEGs and H.26x standards.

References:

1	Gonzaleze and Woods, "*Digital Image Processing",* 3rd ed., Pearson.
2	Yao Wang, Joem Ostermann and Ya–quin Zhang, *"Video processing and communication"*, 1st Ed., PH Int.
3	M. Tekalp, *"Digital Video Processing",* Prentice Hall International

PROGRAM SPECIFIC ELECTIVE - I

COMPUTER VISION

CEC 211

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To introduce students the fundamentals of image formation and the major ideas, methods, and techniques of computer vision and pattern recognition;*
2. *To develop an appreciation for various issues in the design of computer vision and object recognition systems;*
3. *To provide the student with programming experience from implementing computer vision and object recognition applications.*

Outcomes: *At the end of this course, students will be able to:*

1. Identify basic concepts, terminology, theories, models and methods in the field of computer vision.
2. Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.
3. Study the image formation models and feature extraction for computer vision
4. Identify the segmentation and motion detection and estimation techniques
5. Develop small applications and detect the objects in various applications

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Image Formation Models: Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel, Binocular Stereopsis: Camera and Epipolar Geometry; Homography,Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel, Stereovision
UNIT – II
Feature Extraction: Image representations (continuous and discrete), Edge detection, Edge linking, corner detection,texture, binary shape analysis, boundary pattern analysis, circle and ellipse detection, Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion

and edges.
UNIT – III
Shape Representation and Segmentation: Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multi-resolution analysis, Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation
UNIT – IV
Motion Detection and Estimation: Regularization theory, Optical computation, Stereo Vision, Motion estimation, Background Subtraction and Modelling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation, Structure from motion, Motion Tracking in Video
UNIT – V
Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition *Applications of Computer Vision:* Automated Visual Inspection, Inspection of Cereal Grains, Surveillance, In-Vehicle Vision Systems, CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing

References:

1	D. Forsyth and J. Ponce, "*Computer Vision - A modern approach*", Prentice Hall
2	B. K. P. Horn, "*Robot Vision*", McGraw-Hill.
3	Richard Szeliksy *"Computer Vision: Algorithms and Applications"* (http://szeliski.org/Book/)
4	Haralick& Shapiro, "*Computer and Robot Vision*", Vol II
5	G. erard Medioni and Sing Bing Kang "*Emerging topics in computer vision*"
6	Emanuele Trucco and AllessandroVerri, *"Introductory Techniques for 3-D Computer Vision*", Prentice Hall, 1998.
7	Olivier Faugeras, *"Three-Dimensional Computer Vision*", The MIT Press, 1993

DSP ARCHITECTURE

EC 212

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To give an exposure to the various fixed point*
2.	*A floating-point DSP architecture and*
3.	*To develop applications using these processors.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Identify and formalize architectural level characterization of P-DSP hardware*
2.	*Design and implement signal processing modules in DSPs*
3.	*Ability to design, programming (assembly and C), and testing code using Code Composer Studio environment*
4.	*Deployment of DSP hardware for Control, Audio and Video Signal processing Applications*
5.	*Understanding of major areas and challenges in DSP based embedded systems*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT), IEEE standard for Fixed- and Floating-Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.

UNIT – II

Structural and Architectural Considerations: Parallelism in DSP processing, Texas InstrumentsTMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family, TMS320C25 –Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverse Addressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examples for assembly coding.

UNIT – III

VLIW Architecture: Current DSP Architectures, GPUs as an alternative to DSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed Cand Assembly

Language programming, On-chip peripherals, Simple applications developments as an embedded environment.
UNIT – IV
Multi-core DSPs: Introduction to Multi-core computing and applicability for DSP hardware, Concept of threads, introduction to P-thread, mutex and similar concepts, heterogeneous and homogenous multi-core systems, Shared Memory parallel programming –OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing like for loop, sections, TI TMS320C6678 (Eight Core subsystem).
UNIT – V
FPGA based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design-case study of a complete design of DSP processor. High Performance Computing using P-DSP: Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.

References:

1	B. Venkataramani & M. Bhaskar, *"Digital Signal Processor, Architecture, Programming and Applications"*, (2/e), McGraw- Hill,2010
2	S. Srinivasan & Avtar Singh, *"Digital Signal Processing, Implementations using DSP Microprocessors with Examples*", TMS320C54X, Brooks/Cole, 2004.
3	Sen M. Kuo & Woon-Seng S. Gan, *"Digital Signal Processors: Architectures, Implementations, and Applications",* Prentice Hall, 2004
4	C. Marven & G. Ewers, *"A Simple approach to digital signal processing*", Wiley Inter science, 1996.
5	R.A. Haddad & T.W. Parson, "*Digital Signal Processing: Theory, Applications and Hardware*", Computer Science Press NY, 1991.

IOT AND APPLICATIONS

EC 213

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Students will be explored to the interconnection*
2. *Students will be explored to integration of the physical world and the cyber space.*
3. *They are also able to design & develop IOT Devices.*

Outcomes: *At the end of this course, students will be able to:*

1. Understand the concept of IOT and M2M
2. Study IOT architecture and applications in various fields
3. Study the security and privacy issues in IOT.
4. Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
5. Able to understand building blocks of Internet of Things and characteristics.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
IoT& Web Technology the Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.
UNIT – II
M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.
UNIT – III
IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT – IV
IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.
UNIT – V
Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

References:

1	Vijay Madisetti, Arshdeep Bahga, *"Internet of Things A Hands-On- Approach*", 2014, ISBN:978 0996025515
2	Francis daCosta, *"Rethinking the Internet of Things: A Scalable Approach to Connecting Everything"*, 1stEdition, Apress Publications, 2013.
3	CunoPfister, *"Getting Started with the Internet of Things"*, O_Reilly Media, 2011.
4	Adrian McEwen, *"Designing the Internet of Things",* Wiley Publishers, 2013, ISBN: 978-1-118-43062-0

PROGRAM SPECIFIC ELECTIVE - II

WIRELESS SENSOR NETWORKS

EC 214

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*Wide range of applications such as disaster management, military and security have fueled the interest in sensor networks during the past few years. Sensors are typically capable of wireless communication and are significantly constrained in the amount of available resources such as energy, storage and computation. Such constraints make the design and operation of sensor networks considerably different from contemporary wireless networks, and necessitate the development of resource conscious protocols and management techniques.*
2.	*This course provides a broad coverage of challenges and latest research results related to the design and management of wireless sensor networks.*
3.	*Covered topics include network architectures, node discovery and localization, deployment strategies, node coverage, routing protocols, medium access arbitration, fault-tolerance, and network security.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Design wireless sensor network system for different applications under consideration.*
2.	*Understand the hardware details of different types of sensors and select right type of sensor for various applications.*
3.	*Understand radio standards and communication protocols to be used for wireless sensor network-based systems and application.*
4.	*Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.*
5.	*Handle special issues related to sensors like energy conservation and security challenges.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.

UNIT – II
Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (Operating Systems): tinyOS, MANTIS, Contiki, and RetOS.
UNIT – III
Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)
UNIT – IV
Overview of sensor network protocols (details of atleast 2 important protocol per layer): Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.
UNIT – V
Data dissemination and processing; differences compared with other database management systems, data storage; query processing. Specialized features: Energy preservation and efficiency; security challenges; fault tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network.

References:

1	H. Karl and A. Willig, *"Protocols and Architectures for Wireless Sensor Networks"*, John Wiley & Sons, India, 2012.
2	C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, *"Wireless Sensor Networks",* Springer Verlag, 1st Indian reprint, 2010.
3	F. Zhao and L. Guibas, *"Wireless Sensor Networks: An Information Processing Approach"*, Morgan Kaufmann, 1st Indian reprint, 2013.
4	YingshuLi, MyT. Thai, Weili Wu, "*Wireless sensor Network and Applications*", Springer series on signals and communication technology, 2008.

BIOMEDICAL SIGNAL PROCESSING

EC 215

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To understand the basic signals in the field of biomedical. and study origins and characteristics of some of the most commonly used biomedical signals, including ECG, EEG, evoked potentials, and EMG. 3.*
2. *To understand Sources and characteristics of noise and artifacts in bio signals. 4. To understand use of bio signals in diagnosis, patient monitoring and physiological investigation 5.*
3. *To explore research domain in biomedical signal processing. 6. To explore application of established engineering methods to complex biomedical signals problems.*

Outcomes: *At the end of this course, students will be able to:*

1. Understand different types of biomedical signal.
2. Identify and analyze different biomedical signals.
3. Find applications related to biomedical signal processing
4. *The student will be able to model a biomedical system*
5. *Students will be able to analyze ECG and EEG signal with characteristic feature points*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters
UNIT – II
Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing, Digital filtering
UNIT – III
Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet

(time frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)
UNIT – IV
Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications.
UNIT – V
Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis Multiresolution analysis(MRA) and wavelets, Principal component analysis(PCA), Independent component analysis(ICA) Pattern classification–supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples.

References:

1	W. J. Tompkins, "*Biomedical Digital Signal Processing*", Prentice Hall, 1993.
2	Eugene N Bruce, *"Biomedical Signal Processing and Signal Modeling*", John Wiley & Son's publication, 2001.

REMOTE SENSING

EC 216

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*The course is designed to fulfill the following objectives 1. To provide exposure to students in gaining knowledge on concepts and applications leading to modeling of earth resources management using Remote Sensing*
2.	*To acquire skills in storing, managing digital data for planning and development.*
3.	*To acquire skills in advance techniques such as hyper spectral, thermal and LiDAR scanning for mapping, modeling and monitoring.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Understand basic concepts, principles and applications of remote sensing, particularly the geometric and radiometric principles;*
2.	*Provide examples of applications of principles to a variety of topics in remote sensing, particularly related to data collection, radiation, resolution, and sampling.*
3.	*Fully equipped with concepts, methodologies and applications of Remote Sensing Technology.*
4.	*Prepare the candidates for National and Global Employability*
5.	*Acquire skills in handling instruments, tools, techniques and modeling while using Remote Sensing Technology and It empowers the candidate with confidence and leadership qualities.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Physics of Remote Sensing: Electro Magnetic Spectrum, Physics of Remote Sensing-Effects of Atmosphere-Scattering–Different types–Absorption-Atmospheric Window-Energy interaction with surface features –Spectral reflectance of vegetation, soil and water atmospheric influence on spectral response patterns-multi concept in Remote sensing.
UNIT – II
Data Acquisition: Types of Platforms–different types of aircrafts-Manned and Unmanned spacecrafts–sun synchronous and geo synchronous satellites –Types and characteristics of

different platforms –LANDSAT, SPOT, IRS, INSAT, IKONOS, QUICKBIRD etc
UNIT – III
Photographic products, B/W, color, color IR film and their characteristics –resolving power of lens and film -Opto mechanical electro optical sensors –across track and along track scanners-multispectral scanners and thermal scanners–geometric characteristics of scanner imagery - calibration of thermal scanners.
UNIT – IV
Scattering System: Microwave scatterometry, types of RADAR –SLAR –resolution – range and azimuth –real aperture and synthetic aperture RADAR. Characteristics of Microwave images topographic effect-different types of Remote Sensing platforms –airborne and space borne sensors -ERS, JERS, RADARSAT, RISAT -Scatterometer, Altimeter-LiDAR remote sensing, principles, applications.
UNIT – V
Thermal and Hyper Spectral Remote Sensing: Sensors characteristics-principle of spectroscopy-imaging spectroscopy–field conditions, compound spectral curve, Spectral library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing – thermal sensors, principles, thermal data processing, applications. *Data Analysis:* Resolution–Spatial, Spectral, Radiometric and temporal resolution-signal to noise ratio-data products and their characteristics-visual and digital interpretation–Basic principles of data processing –Radiometric correction–Image enhancement–Image classification–Principles of LiDAR, Aerial Laser Terrain Mapping.

References:

1	Lillesand T.M., and Kiefer,R.W, "*Remote Sensing and Image interpretation*", John Wiley & Sons-2000, 6thEdition
2	John R. Jensen, *"Introductory Digital Image Processing: A Remote Sensing Perspective*", 2nd Edition, 1995.
3	John A.Richards, *"Remote Sensing Digital Image Analysis",*1999. Springer –Verlag
4	Paul Curran P.J, *"Principles of Remote Sensing",* ELBS; 1995.
5	Frederic k. lutgens, kennth G.pinzke and Edward j. tarbuck, *"Applications and Investigation in Earth science",* 2008.
6	Glencoe science, "*Physical science with earth science*", 2005. 20
7	Sebins,F., "*Remote Sensing principles and interpretation*", W.H.Freeman and company Newyork 1987

RESEARCH METHODOLOGIES IN ECE

EC 100

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To know the motivation on research philosophy and processes in general.
2. To be able to formulate the problem statement and prepare research plan for the problem under investigation through literature.
3. To be able to apply various techniques for data analysis and patenting

Outcomes:

1. Students able to understand research methodology and problems
2. Able to define the techniques involved in defining problem
3. Able to Developing a Research plan and research set up
4. Able to analyze the collection of data and statistical analysis
5. Able to have knowledge on writing the report and patenting

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Objectives and Types of research: Objectives and Motivation of research- types of research- Research approaches – Significance of Research-Research Methods versus Methodology- Research and Scientific method- Importance of research methodology – Research process- criteria of good research- Problems encountered by Researchers in India-benefits to society in general.
UNIT – II
Research formulation: Defining and formulating the research problem, selecting the problem, importance of literature review in define a problem, literature review, primary and secondary sources, reviews, monograms, patents, research data bases web as a source, identifying gap areas from literature review and research data bases, devilment of working hypothesis
UNIT – III
Research Design and methods: Meaning of research design - need of research design- features of a good design- important concepts relating to research design- different research designs- Basic Principles of experimental designs- Developing a Research plan-Exploration, descriptions diagnosis and experiment

UNIT – IV
Execution of the research and data collection: Aspect of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis, strategies and tool, data analysis with statistical packages (sigma STAT, SPSS for student test t-test, ANOVA, etc.) hypothesis testing, generalization and interpretation.
UNIT – V
Reporting and thesis writing: Structure and components of scientific reports, types of report, technical report and thesis. Thesis writing-different steps and software tools (word processing) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, illustrations and tables, bibliography, referencing and footnotes. Use of visual aids. *Patenting:* The Basics of the Patent System, Patent Law, How to Read a Patent, Protecting Invention and Planning Patent Filing, Preparing Patent Application

References:

1	C.R.Kothari, "*Research methodology, Methods & technique*", New age international publishers, 2004.
2	R.Ganesan, "*Research Methodology for Engineers*", MJP Publishers: Chennai, 2011.
3	P.Ramdass and A.Wilson Aruni, *"Research and Writing across the disciplines",* MJP Publishers, Chennai 2009
4	Matthew Y Ma, "Fundamentals of Patenting and Licensing for Scientists and Engineers" 2nd Edition 2015

AUDIT COURSE-I
ENGLISH FOR RESEARCH PAPER WRITING

AC 101

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*Understand that how to improve your writing skills and level of readability*
2.	*Understand the nuances of language and vocabulary in writing a Research Paper.*
3.	*Develop the content, structure, format of writing a research paper and produce original research papers without plagiarism*

Outcomes: *At the end of this course, students will be able to:*

1.	*Interpret the nuances of research paper writing.*
2.	*Differentiate the research paper format and citation of sources.*
3.	*To review the research papers and articles in a scientific manner.*
4.	*Avoid plagiarism and be able to develop their writing skills in presenting the research work.*
5.	*Create a research paper and acquire the knowledge of how and where to publish their original research papers*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.
UNIT – II
Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.
UNIT – III
Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.
UNIT – IV
Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing - The final draft and proof reading.
UNIT – V
Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications –

Advantages/Benefits *Presentation Skills:* Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

References:

1	C. R Kothari, Gaurav, Garg, "*Research Methodology Methods and Techniques*", 4/e, New Age International Publishers.
2	Day R, "*How to Write and Publish a Scientific Paper"***,** Cambridge University Press, 2006
3	"*MLA Hand book for writers of Research Papers*", 7/e, East West Press Pvt. Ltd, New Delhi
4	Lauri Rozakis, Schaum's, "*Quick Guide to Writing Great Research Papers"*, Tata McGraw Hills Pvt. Ltd, New Delhi.

SANSKRIT FOR TECHNICAL KNOWLEDGE

AC 102

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
3. To explore the huge knowledge from ancient Indian literature

Outcomes: *At the end of this course, students will be able to:*

1. Develop passion towards Sanskrit language
2. Decipher the latent engineering principles from Sanskrit literature
3. Correlates the technological concepts with the ancient Sanskrit history.
4. Develop knowledge for the technological progress
5. Explore the avenue for research in engineering with aid of Sanskrit

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)
UNIT – II
Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series). The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).
UNIT – III
Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering): Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower- Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)
UNIT – IV
Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vedic

command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.
UNIT – V
Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthi yanthram

References:

1	M Krishnamachariar, "*History of Classical Sanskrit Literature",* TTD Press, 1937.
2	M.R. Kale, "*A Higher Sanskrit Grammar: For the Use of School and College Students*", Motilal Banarsidass Publishers, 2015.
3	Kapail Kapoor, "*Language, Linguistics and Literature: The Indian Perspective",* ISBN-10: 8171880649, 1994.
4	"*Pride of India*", Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5	Shri Rama Verma, "*Vedas the source of ultimate science",* Nag publishers, 2005.

VALUE EDUCATION

AC 103

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Understand the need and importance of Values for self-development and for National development.*
2. *Imbibe good human values and Morals*
3. *Cultivate individual and National character.*

Outcomes: *At the end of this course, students will be able to:*

1. *Gain necessary Knowledge for self-development*
2. *Learn the importance of Human values and their application in day to day professional life.*
3. *Appreciate the need and importance of interpersonal skills for successful career and social life*
4. *Emphasize the role of personal and social responsibility of an individual for all-round growth.*
5. *Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.
UNIT – II
Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.
UNIT – III
Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.
UNIT – IV
Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy

books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.
UNIT – V
Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

References:

1	Chakroborty, S.K., *"Values & Ethics for organizations Theory and practice*", Oxford University Press, New Delhi, 1998.
2	2. Jaya Dayal Goyandaka, "*Srimad Bhagavad Gita with Sanskrit Text*", Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur, 2017.

CONSTITUTION OF INDIA

AC 104

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective*
2.	*To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role*
3.	*Entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.*
2.	*Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.*
3.	*Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru*
4.	*The eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.*
5.	*Discuss the passage of the Hindu Code Bill of 1956.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.
UNIT – II
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
UNIT – III
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT – IV
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
UNIT – V
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

1	*"The Constitution of India",* 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, *"Dr. B. R. Ambedkar framing of Indian Constitution",* 1st Edition, 2015.
3	M. P. Jain, "*Indian Constitution Law",* 7th Edn., Lexis Nexis, 2014.
4	D.D. Basu, *"Introduction to the Constitution of India",* Lexis Nexis, 2015.

ADVANCED DIGITAL SIGNAL PROCESSING LAB

EC 251

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1. *Design and implement a DSP system using tools like MATLAB*
2. *Analyze and describe the functionality of a real-world DSP system and work in teams to plan and execute the creation of a complex DSP system*
3. *Apply DSP system design to real world applications and implement signal processing algorithms on DSP processors.*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand the handling of discrete/digital signals using MATLAB*
2. *Understand the basic operations of Signal processing*
3. *Analyze the spectral parameter of window functions*
4. *Design IIR, and FIR filters for band pass, band stop, low pass and high pass filters.*
5. *Design the signal processing algorithm using MATLAB & and implementation on DSP processor*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

List of Experiments:

1. Basic Signal Representation
2. Correlation Auto and Cross
3. Stability Using Hurwitz Routh Criteria
4. Sampling FFT Of Input Sequence
5. Butterworth Low pass And High pass Filter Design
7. Chebychev Type I, II Filter
8. State Space Matrix from Differential Equation
9. Normal Equation Using Levinson Durbin
10. Decimation and Interpolation Using Rationale Factors
11. Maximally Decimated Analysis DFT Filter
12. Cascade Digital IIR Filter Realization
13. Convolution and M Fold Decimation &PSD Estimator
14. Estimation Of PSD
15. Inverse Z Transform
16. Group Delay Calculation
17. Separation Of T/F
18. Parallel Realization of IIR filter

SEMINAR – I

EC 261

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Outcomes: *At the end of this course, students will be able to:*

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

SEMESTER – II

PATTERN RECOGNITION AND MACHINE LEARNING

EC 203

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1. *To equip students with basic mathematical and statistical techniques commonly used in pattern recognition.*
2. *To introduce students to a variety of pattern recognition algorithms.*
3. *Enable students to apply machine learning concepts in real life problems.*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand machine learning concepts and range of problems that can be handled by machine learning.*
2. *Compare and parameterize different learning algorithms.*
3. *Study the parametric and linear models for classification*
4. *Design neural network and SVM for classification*
5. *Develop machine independent and unsupervised learning techniques.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to Pattern Recognition: Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error Analysis.
UNIT – II
Linear models: Linear Models for Regression, linear regression, logistic regression Linear Models for Classification.
UNIT – III
Neural Network: perceptron, multi-layer perceptron, backpropagation algorithm, error surfaces, practical techniques for improving backpropagation, additional networks and training methods, Adaboost, Deep Learning.
UNIT – IV
Linear discriminant functions - decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support

vector machine.
UNIT – V
Algorithm independent machine learning – lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers.
UNIT – VI
Unsupervised learning and clustering **–** k-means clustering, fuzzy k-means clustering, hierarchical clustering

References:

1	Richard O. Duda, Peter E. Hart, David G. Stork*, "Pattern Classification*", 2nd Edition John Wiley & Sons, 2001
2	Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, *"The Elements of Statistical Learning",* 2nd Edition, Springer, 2009.
3	C. Bishop, "*Pattern Recognition and Machine Learning*", Springer, 2006.

DETECTION AND ESTIMATION THEORY

EC 204

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Use classical and Bayesian approaches to formulate and solve problems for parameter estimation from noisy signals.*
2. *Use hypothesis testing and Bayesian approaches to formulate and solve problems for signal detection from noisy signals.*
3. *Derive and apply linear filtering methods for parameter estimation and signal smoothing*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand the mathematical background of signal detection and estimation*
2. *Use classical and Bayesian approaches to formulate and solve problems for signal detection and parameter estimation from noisy signals.*
3. *Derive and apply filtering methods for parameter estimation.*
4. *Understand the mathematical background of signal detection and estimation*
5. *Use classical and Bayesian approaches to formulate and solve problems for signal detection and parameter estimation from noisy signals*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Random Processes: Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes.
UNIT – II
Detection Theory: Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)-minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability of Error, General Gaussian Problem, Composite Hypotheses.
UNIT – III
Linear Minimum Mean-Square Error Filtering: Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

UNIT – IV
Statistics: Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.
UNIT – V
Estimating the Parameters of Random Processes from Data: Tests for Stationarity and Ergodicity, Model-free Estimation, Model-based Estimation of Autocorrelation Functions, Power Special Density Functions.

References:

1	K. Sam Shanmugan & A.M. Breipohl, *"Random Signals: Detection, Estimation and Data Analysis"*, Wiley India Pvt. Ltd, 2011.
2	Lonnie C. Ludeman, *"Random Processes: Filtering, Estimation and Detection"*, Wiley India Pvt. Ltd., 2010.
3	Steven.M.Kay, *"Fundamentals of Statistical Signal Processing: Volume I Estimation Theory*", Prentice Hall, USA, 1998.
4	Steven.M.Kay, *"Fundamentals of Statistical Signal Processing: Volume I Detection Theory Prentice"*, Hall, USA, 1998.
5	Srinath, Rajasekaran, Viswanathan, *"Introduction to Statistical Signal Processing with Applications*", 2003, PHI.
6	Louis L.Scharf, *"Statistical Signal Processing: Detection, Estimation and Time Series Analysis"*, 1991, Addison Wesley.
7	Harry L. Van Trees, *"Detection, Estimation and Modulation Theory: Part – I",* 2001, John Wiley & Sons, USA.
8	Mischa Schwartz, Leonard Shaw, *"Signal Processing: Discrete Spectral Analysis – Detection & Estimation"*, 1975, Mc Graw Hill.

PROGRAM SPECIFIC ELECTIVE - III

WIRELESS AND MOBILE COMMUNICATIONS

EC 114

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*An overview of key wireless technologies: Various generations of mobile communications for voice and data, cordless, paging, fixed and mobile broadband wireless systems, and beyond*
2.	*Wireless system design fundamentals: channel assignment, handoffs, interference, frequency reuse, capacity planning, large-scale fading, and Outdoor, Indoor propagation models and Path loss, small-scale fading, multipath, reflection, diffraction, scattering and Various statistical models for small-scale fading study*
3.	*Various Diversity techniques, Equalizers used in communication receivers, Multiple Access techniques and their applications in wireless networks*

Outcomes: *At the end of this course, students will be able to:*

1.	*Develop design models for cellular systems.*
2.	*Analyze the various Large-scale fading effects in designing propagation models for Mobile communications in Outdoor environments.*
3.	*Analyze the various types of Small-scale fading, measurement techniques, Parameters of multi-path radio and Statistical models.*
4.	*Understand Various Diversity techniques and Equalizers used in communication receivers.*
5.	*Develop the design models for various multiple access techniques and understand their spectral efficiencies.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction to Wireless Communication Systems and the Cellular Concept
Evolution of Mobile Radio Communications, Examples of Wireless Communication Systems, Overview of 1G,2G, 2.5 G,3 G, 4G and 5G Cellular networks.
The Cellular Concept: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff

Strategies, Interference and System Capacity, Improving Coverage and Capacity in cellular systems.
UNIT – II
Mobile Radio Propagation: Large-Scale Path Loss: Introduction to Radio wave propagation, Free space propagation model, Relating Power to Electric Field, the three basic propagation mechanisms- Reflection, Ground Reflection (Two Ray) model, Diffraction, Scattering. *Outdoor propagation models:* Longley-Rice model, Okumura model, Hata model, PCS Extension to Hata model, Walfisch and Bertoni Model, Wideband PCS Microcell model. *Indoor propagation models:* Partition losses (same floor), Partition losses between floors, Log-distance path loss model, Ericsson multiple breakpoint model, Attenuation factor model, and Signal penetration into buildings.
UNIT – III
Mobile Radio Propagation: Small Fading and Multipath: Small scale multipath propagation, Factors influencing small scale fading, Doppler shift, Small scale multipath Measurements-Direct RF Pulse System, Spread Spectrum Sliding correlator Channel Sounding, Frequency Domain Channels Sounding, Parameters of Mobile multipath channels, Types of Small Scale Fading, Statistical models for multipath Fading Channels-Clarke's model for flat fading, spectral shape due to Doppler, Level Crossings and Fading Statistics, Two-ray Rayleigh Fading model.
UNIT – IV
Equalization and Diversity: Introduction, Fundamentals of Equalization, Training a Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Nonlinear Equalization-Decision Feedback Equalization (DFE), Maximum Likelihood Sequence Estimation (MLSE) Equalizer, Algorithms for adaptive equalization *Diversity Techniques*: Practical Space Diversity Considerations, Selection Diversity, Scanning Diversity, Maximal Ratio Combining, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver.
UNIT – V
Multiple Access Techniques for Wireless Communications: FDMA, TDMA, Spread Spectrum Multiple Access- FHMA and CDMA, SDMA, Spectral efficiency analysis for Multiple Access Technologies: FDMA, TDMA and CDMA Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas.

References:

1	Theodore, S. Rappaport, *"Wireless Communications, Principles and Practice"*, 2nd Ed.,2002, PHI publication.
2	2. Andrea Goldsmith, *"Wireless Communications*", 2005, Cambridge University Press.
3	Kaveh pah Laven and P.Krishna Murthy, *"Principles of Wireless networks",* 2002,PE.
4	P.Nicopolitidis, M.S.Obaidat, G.I.Papadimitriou, A.S.Pomportsis, *"Wireless Networks"*, 200, John Wiley & Sons Pte Ltd.
5	Ashok Raj, *"Wireless Communication*", First Edition, 2014, Khanna Publishers.

AUDIO PROCESSING

EC 217

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To introduce the models of speech production and acoustic phonetics*
2. *To teach time and frequency domain techniques for estimating speech parameters and teach predictive techniques for speech coding*
3. *To introduce speech recognition and speech synthesis applications Course Outcomes*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand different characteristics of Speech.*
2. *Identify and analyze different speech analysis system.*
3. *Write algorithms for Recognition of speech.*
4. *Demonstrate basic knowledge in speech production mechanism, phoneme classification, digital models for speech production, Homomorphic speech processing and LPC analysis*
5. *Demonstrate applications of signal processing theory for estimation of speech parameters in time and frequency domain including pitch and formants*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

The process of speech production: Production Mechanism and acoustic phonetics. Digital models for speech signals: Vocal Tract, Radiation, Excitation and complete model speech perception: Loudness, Bark Scale, masking, perception and Psychoacoustics.

UNIT – II

Short-time Period analysis: Short-time energy, Average magnitude, zero crossing, Speech vs Silence discrimination and zero crossing rate, Pitch period estimation using parallel processing approach. Autocorrelation function, Pitch period estimation using Auto correlation function, The average magnitude function, median smoothing. Short time Fourier Analysis: Fourier transform interpretation, linear filtering interpretation, sampling rates in time and frequency, Filter banks, Spectrograms, pitch detection. Cepstral analysis, Complex and real cepstrum, pitch detection and Formant estimation.

UNIT – III
Digital speech representation and coding: Review of PCM, adaptive PCM, differential PCM, delta modulation. Linear Predictive coding (LPC) analysis: Basic principles, autocorrelation and covariance methods, Computation of LP coefficients, Cholesky decomposition, Durbin's recursive solution, Frequency domain interpretation of LPC, CELP.
UNIT – IV
Analysis by synthesis: Phase vocoder, subband coding, Formant/homomorphic vocoder, cepstral vocoder, vector Quantizer coder, Speech Enhancement techniques: Spectral subtraction, enhancement by resynthesis.
UNIT – V
Automatic speech recognition: Basic pattern recognition approaches, Evaluating the similarity of speech patterns, Dynamic Time Warping (DTW), HMM's for speech recognition, forward, backword algorithms and parameter estimation. Speaker recognition, Features that distinguish speakers.

References:

1	Rabinar and Schafer, "*Digital Processing of Speech Signals",* Pearson Education, 2004.
2	Deller, Hansen, Proakis, *"Discrete-Time Processing of Speech signals*", IEEE presses, 2000
3	R & J Rabinar and Juang, *"Fundamentals of speech recognition",* Prentice Hall, 1993.
4	Douglas O'Shaughnessy, *"Speech Communication: Human and Machine*", 2nd ed., University press, Hyderabad, 2001.

VOICE AND DATA NETWORKS

EC 218

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand the network design and performance issues
2. To differentiate between layered and layered less communication
3. To familiarize with query models and internetwork.

Outcomes: *At the end of this course, students will be able to:*

1. Protocol, algorithms, trade-offs rationale.
2. Routing, transport, DNS resolutions
3. Network extensions and next generation architectures.
4. QoS and packet scheduling algorithms
5. To understand the inter-networking and packet scheduling

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.
UNIT – II
Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.
UNIT – III
Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.
UNIT – IV
Queuing Models of Networks, Traffic Models, Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols, Aloha System, Carrier Sensing, Examples of Local area networks,
UNIT – V
Inter-networking, Bridging, Global Internet, IP protocol and addressing, Sub netting, Classless Inter domain Routing (CIDR), IP address lookup, Routing in Internet. End to End Protocols,

TCP and UDP. Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery, Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.

References:

1	D. Bertsekas and R. Gallager, *"Data Networks*", 2nd Edition, Prentice Hall, 1992.
2	L. Peterson and B. S. Davie, *"Computer Networks: A Systems Approach",*5th Edition, Morgan Kaufman, 2011.
3	Kumar, D. Manjunath and J. Kuri, *"Communication Networking: An analytical approach"*, 1st Edition, Morgan Kaufman, 2004.
4	Walrand, *"Communications Network: A First Course*", 2nd Edition, McGraw Hill, 2002.
5	Leonard Kleinrock, *"Queueing Systems, Volume I: Theory"*, 1st Edition, John Wiley and Sons, 1975.
6	Aaron Kershenbaum, "*Telecommunication Network Design Algorithms",* McGraw Hill, 1993.

PROGRAM SPECIFIC ELECTIVE - IV

ADAPTIVE SIGNAL PROCESSING

EC 219

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand the basics of adaptive system
2. To make familiar with gradient search algorithms and functions
3. To introduce LMS & RLS algorithms

Outcomes: *At the end of this course, students will be able to:*

1. To understand theory of different filters and algorithms
2. To understand theory of multi rate DSP, solve numerical problems and write algorithms
3. To understand theory of prediction and solution of normal equations
4. To know applications of DSP at block level.
5. To understand Kalman Filter theory

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Approaches to the development of adaptive filter theory. Introduction to filtering, smoothing and prediction. Wiener filter theory, introduction; Error performance surface; Normal equation; Principle of orthogonality; Minimum mean squared error; example.
UNIT – II
Gradient algorithms; Learning curves; LMS gradient algorithm; LMS stochastic gradient algorithms; convergence of LMS algorithms.
UNIT – III
Applications of adaptive filter to adaptive noise cancelling, Echo cancellation in telephone circuits and adaptive beam forming.
UNIT – IV
Kalman Filter theory; Introduction; recursive minimum mean square estimation for scalar random variables; statement of the kalman filtering problem: the innovations process; Estimation of state using the innovations process; Filtering examples.
UNIT – V
Vector Kalman filter formulation. Examples. Applications of kalman filter to target tracking.

[PTO]

References:

1	Sophoclas, *J.* Orphanidies, *"Optimum signal processing an introduction*", McMillan, 1985
2	Simon Haykins, *"Adaptive signal processing",* PHI, 1986.
3	Bernard Widrow, *"Adaptive signal processing",* PHI, 1986.
4	Bozic. SM., "Digital and Kalman Filtering"

ARTIFICIAL NEURAL NETWORKS

EC 220

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To understand the biological neural network and to model equivalent neuron models.*
2.	*To understand the architecture, learning algorithm and issues of various feed forward and feedback neural networks*
3.	*To gain knowledge on applications of ANN*

Outcomes: *At the end of this course, students will be able to:*

1.	*learn the ideological basics of artificial neural networks*
2.	*Create different neural networks of various architectures*
3.	*Learn supervised learning and unsupervised learning.*
4.	*Learn SOM in ANN*
5.	*To know some application of artificial neural networks*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process

UNIT – II

Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection

UNIT – III

Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning

UNIT – IV
Self-Organization Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification
UNIT – V
Neuro Dynamics: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, Computer Experiment

References:

1	Simon Haykin, "*Neural Networks a Comprehensive Foundations*", PHI edition.
2	B. Vegnanarayana, "*Artificial Neural Networks",* Prentice Hall of India P Ltd 2005
3	Li Min Fu, "*Neural Networks in Computer Inteligance*", MCGRAWHILL EDUCATION 2003
4	James A Freeman David M S Kapura, "*Neural Networks",* Pearson Education 2004.
5	Jacek M. Zurada, "*Introduction to Artificial Neural Systems",* JAICO Publishing House Ed. 2006.

OPTIMIZATION TECHNIQUES

EC 221

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To introduce various optimization techniques i.e classical, linear programming, transportation problem, simplex algorithm, dynamic programming*
2. *Constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations*
3. *To explain the concept of Dynamic programming and its applications to project implementation*

Outcomes: *At the end of this course, students will be able to:*

1. *Explain the need of optimization of engineering systems*
2. *Understand optimization of electrical and electronics engineering problems*
3. *Apply classical optimization techniques, linear programming, simplex algorithm, transportation problem*
4. *Apply unconstrained optimization and constrained non-linear programming and dynamic programming*
5. *Formulate optimization problems.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Use of optimization methods. Introduction to classical optimization techniques, motivation to the simplex method, simplex algorithm, sensitivity analysis.
UNIT – II
Search methods - Unrestricted search, exhaustive search, Fibonocci method, Golden section method, Direct search method, Random search methods, Univariate method, simplex method, Pattern search method.
UNIT – III
Descent methods, Gradient of function, steepest decent method, conjugate gradient method. Characteristics of constrained problem, Direct methods, The complex method, cutting plane method.

UNIT – IV
Review of a global optimization techniques such as Monte Carlo method, Simulated annealing and Tunneling algorithm.
UNIT – V
Generic algorithm - Selection process, Crossover, Mutation, Schema theorem, comparison between binary and floating-point implementation.

References:

1	SS Rao, *"Optimization techniques*", PHI, 1989
2	Zhigmiew Michelewicz, *"Genetic algorithms + data structures = Evaluation programs"*, Springer Verlog - 1992.
3	Merrium C. W., *"Optimization theory and the design of feedback control systems"*, McGraw Hill, 1964.
4	Weldo D.J., *"Optimum seeking method",* PHI, 1964.

AUDIT COURSE –II
DISASTER MANAGEMENT

AC 105

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters*
2.	*To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters*
3.	*To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Learn to demonstrate a critical understanding of key concepts in disaster risk reduction*
2.	*Humanitarian response*
3.	*Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.*
4.	*Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.*
5.	*Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT – II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT – III
Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics
UNIT – IV
Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.
UNIT – V
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

References:

1	R. Nishith, Singh AK, *"Disaster Management in India: Perspectives, issues and strategies"*, New Royal Book Company.
2	Sahni, Pardeep (Eds.), *"Disaster Mitigation Experiences and Reflections"*, PHI, New Delhi.
3	Goel S. L., *"Disaster Administration and Management Text and Case Studies",* Deep & Deep Publication Pvt. Ltd., New Delhi.

PEDAGOGY STUDIES

AC 106

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *To present the basic concepts of design and policies of pedagogy studies.*
2. *To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices and familiarize various theories of learning and their connection to teaching practice.*
3. *To create awareness about the practices followed by DFID, other agencies and other researchers and provide understanding of critical evidence gaps that guides the professional development*

Outcomes: *At the end of this course, students will be able to:*

1. *Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.*
2. *Examine the effectiveness of pedagogical practices.*
3. *Understand the concept, characteristics and types of educational research and perspectives of research.*
4. *Describe the role of classroom practices, curriculum and barriers to learning.*
5. *Understand Research gaps and learn the future directions.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT – II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT – III

*Evidence on the Effectiveness of Pedagogical Practices***:** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT – IV
Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.
UNIT – V
Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

References:

1	Ackers J, Hardman F, *"Classroom Interaction in Kenyan Primary Schools, Compare*", 31 (2): 245 – 261, 2001.
2	2. Agarwal M, *"Curricular Reform in Schools: The importance of evaluation*", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3	Akyeampong K, "*Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)",* Country Report 1. London: DFID, 2003.
4	Akyeampong K, Lussier K, Pryor J, Westbrook J, *"Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?"* International Journal Educational Development, 33 (3): 272- 282, 2013.
5	Alexander R J, *"Culture and Pedagogy: International Comparisons in Primary Education",* Oxford and Boston: Blackwell, 2001.
6	Chavan M, Read India: *"A mass scale, rapid, learning to read campaign",* 2003

STRESS MANAGEMENT BY YOGA

AC 107

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*Creating awareness about different types of stress and the role of yoga in the management of stress.*
2.	*Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
3.	*Prevention of stress related health problems by yoga practice.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Understand yoga and its benefits.*
2.	*Enhance Physical strength and flexibility.*
3.	*Learn to relax and focus.*
4.	*Relieve physical and mental tension through asanas.*
5.	*Improve work performance and efficiency.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.
UNIT – II
Meaning and Definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.
UNIT – III
Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress
UNIT – IV
Asanas - (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.
UNIT – V
Pranayama - Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama. *Meditation Techniques:* Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

References:

1	Janardhan Swami Yogabhyasi Mandal, "*Yogic Asanas for Group Training - Part-I*", , Nagpur.
2	Advaita Ashrama, "*Swami Vivekananda, "Rajayoga or Conquering the Internal Nature",* (Publication Department), Kolkata.
3	Nagendra H.R and Nagaratna R, "*Yoga Perspective in Stress Management",* Swami Vivekananda Yoga Prakashan, Bangalore.

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

AC 108

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Outcomes: *At the end of this course, students will be able to:*

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)
UNIT – II
Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.
UNIT – III
Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48
UNIT – IV
Statements of Basic Knowledge - Shrimad Bhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.
UNIT – V
Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

[PTO]

References:

1	"*Srimad Bhagavad Gita",* Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2	P.Gopinath, *"Bhartrihari's Three Satakam (Niti-sringar-vairagya*)", Rashtriya Sanskrit Sansthanam, New Delhi

DIGITAL IMAGE AND VIDEO PROCESSING LABORATORY

EC 252

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1.	*Understand the basics of image processing system and the concepts of image transforms.*
2.	*Gain knowledge in applying image and video processing algorithms to enhance images.*
3.	*Gain complete knowledge about image compression and segmentation*

Outcomes: *At the end of this course, students will be able to:*

1.	*Analyse relationship between pixels in images and able to apply proper image transform on digital images for the intended application.*
2.	*Apply filtering operations to remove noise in images and to segment the digital images.*
3.	*Apply proper compression techniques on images to save storage space.*
4.	*Analyse the features of the image*
5.	*Use MATLAB to perform video processing applications*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

List of experiments

1. Perform basic operations on images like addition, subtraction etc.
2. Plot the histogram of an image and perform histogram equalization
3. Implement segmentation algorithms
4. Perform video enhancement
5. Perform video segmentation
6. Perform image compression using lossy technique
7. Perform image compression using lossless technique
8. Perform image restoration
9. Convert a colour model into another
10. Calculate boundary features of an image
11. Calculate regional features of an image
12. Detect an object in an image/video using template matching/Bayes classifier

SEMINAR – II

EC 262

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Outcomes: At the end of this course, students will be able to**:**

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

MINI PROJECT WITH SEMINAR

EC 271

Instruction: 6 periods per week *Duration of SEE: --*
CIE:50 marks *SEE: --*
Credits: 3

Outcomes: *At the end of this course, students will be able to:*

1.	*Formulate a specific problem and give solution*
2.	*Develop model/models either theoretical/practical/numerical form*
3.	*Solve, interpret/correlate the results and discussions*
4.	*Conclude the results obtained*
5.	*Write the documentation in standard format*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter-disciplinary/ industry relevance.
- The students can select a mathematical modeling based/Experimental investigations or Numerical modeling
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

SEMESTER – III
PROGRAM ELECTIVE - V
CODING THEORY AND TECHNIQUES

EC 222

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*Learn about Importance of Information and Error Control*
2.	*Describe Linear Block Codes and Applications and learn Cyclic Coding and BCH codes*
3.	*Design Convolutional Encoders and explore latest trends in Coding Theory*

Outcomes: *At the end of this course, students will be able to:*

1.	*Analyse the source of errors present in communication systems*
2.	*Perform Error detection and correction using Linear Block Codes*
3.	*Differentiate between Linear Block Codes and Cyclic Codes*
4.	*Analyse behaviour of convolution encoders*
5.	*Design Turbo Encoders/Decoders and LDPC Encoders/Decoders*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Coding for Reliable Digital Transmission and Storage: Mathematical model of Information, A Logarithmic Measure of Information, Average and Mutual Information and Entropy, Types of Errors, Error Control Strategies.
UNIT – II
Linear Block Codes: Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Applications of Block codes.
UNIT – III
Cyclic Codes: Generator and parity-check matrices of cyclic codes, Syndrome computation and error detection. Binary BCH codes, Decoding of BCH codes and Reed Solomon codes.
UNIT – IV
Convolutional Codes: Polynomial description of convolution code, Generator matrix of convolution code, State diagram, Tree diagram, Trellis diagram, Sequential decoding and Viterbi decoding.
UNIT – V
Turbo Coding: Introduction to turbo coding, Performance analysis of Turbo codes, Design of Turbo codes, decoding of Turbo codes, Introduction to LDPC Codes, Tanner graph for Linear

Block codes.

References:

1	Shu Lin, Daniel J., Costello, Jr., "*Error Control Coding"*, 2nd edition, Pearson, 2011.
2	Simon Haykin, "*Communication Systems"*, 4th Edition, John Wiley & Sons, 2007.
3	Proakis J.G. & M. Salehi, "*Digital Communications"*, Mc Graw-Hill, 2008.
4	Biglieri E., "*Coding for Wireless Channels"*, Springer, 2007.

ADVANCED COMPUTER ARCHITECTURE

EC 111

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To Design Basic Data Path Unit (DPU) and Control Unit (CU) and to Familiarize with Parallel Processing Architectures*
2. *To Develop OpenCL Programming Environment and developing Kernel Programming*
3. *To Know Heterogeneous Architectures*

Outcomes: *At the end of this course, students will be able to:*

1. *To Realize Data Path Unit (DPU) and Control Unit (CU)*
2. *To Analyze the Performance of Multi-Core Architectures*
3. *To Demonstrate OpenCL Programs for real time applications*
4. *To Implement Kernels for Heterogeneous Architectures in OpenCL*
5. *To List and Describe the Challenges in Advanced Parallel Processing Architectures*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Processor Design:

CPU Design – CPU Organization – Data Path Design: Fixed Point Booth's Multiplier, Restoring Division Unit and Non-Restoring Division Unit.

Memory Hierarchy **–** Virtual Memory – Cache Memory

Control Unit Design – Hardwired Control Unit Design of Basic CPU.

Case Studies: Verilog HDL Implementation of Booth's Multiplication, Restoring and Non-Restoring Division and Hardwired Control Unit Realization of Basic CPU

UNIT – II

Multi Core Architectures:

RISC, CISC, Flynn's Classification, Instruction Level Parallelism: Super Scalar, VLIW and EPIC architectures. Scalable, Multithreaded and Dataflow Architectures: Principles of Multithreading, Fine-Grain Multithreading, Scalable and Multithreaded Architectures and Dataflow and Hybrid Architectures.

Case Studies: Threads and OpenMP

UNIT – III
Accelerated Architectures: GPU: nVidia and AMD Architecture – GPU memory and Scheduling, Parallel Programming Development and Environment: MPI – CUDA – OpenCL: Introduction, Platform and Devices, Execution Environment and Memory Model *Case Studies:* OpenCL programming
UNIT – IV
Low Power Architectures: System on Chip Architectures – Raspberry-Pi, nVidia SoC – Basics of Kernels: Kernels, Work-items, Work-groups and Execution Domain, OpenCL Synchronization *Case Studies:* Programming on Raspberry Pi.
UNIT – V
Advances in Parallel Processor Architectures: *Hybrid Architectures* – Issues and Challenges in Heterogeneous Computing, Schedulers, Process Synchronization and Programming *Virtualization* – Processor and Memory *Case Studies:* Hybrid Programming using CPU and GPU

References:

1	Hayes John P, "*Computer Architecture and organization,"* 3rd edition, McGraw Hill Education, 1998.
2	William Stallings, *"Computer Organization and Architecture: Designing for Performance",* 8th edition, PHI, 2007.
3	Hwang and Naresh Jotwani, *"Advanced Computer Architecture: Parallelism, Scalability and Programmability,*" McGraw Hill Education, 2017.
4	Benedict Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry and Dana Schaa, *"Heterogeneous Computing with OpenCL,"* Morgan Kaufmann Publications, 2011.

MULTI SPECTRAL SIGNAL ANALYSIS

EC 223

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand the concept of image processing and its applications
2. To understand the mutual information
3. To familiarize with ICA and support vector machine

Outcomes: *At the end of this course, students will be able to:*

1. Select appropriate hyper spectral data for a particular application.
2. Understand basic concepts of data acquisition and image processing tasks required for multi and hyper spectral data analysis
3. Learn techniques for classification and analysis of multi and hyperspectral data.
4. To understand the concepts of Independent component analysis
5. To understand the basic concepts of support vector machines and its applications

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

*Hyperspectral Sensors and Applications***:** Introduction, Multi-spectral Scanning Systems (MSS), Hyperspectral Systems, Airborne sensors, Spaceborne sensors, Ground Spectroscopy, Software for Hyperspectral Processing, Applications, Atmosphere and Hydrosphere, Vegetation, Soils and Geology, Environmental Hazards and Anthropogenic Activity

UNIT – II

*Overview of Image Processing***:** Introduction, Image File Formats, Image Distortion and Rectification, Radiometric Distortion, Geometric Distortion and Rectification, Image Registration, Image Enhancement, Point Operations, Geometric Operation, Image Classification, Supervised Classification, Unsupervised Classification, Crisp Classification Algorithms, Fuzzy Classification Algorithms, Classification Accuracy Assessment, Image Change Detection, Image Fusion, Automatic Target Recognition

UNIT – III

Mutual Information: A Similarity Measure for Intensity Based Image Registration: Introduction, Mutual Information Similarity Measure, Joint Histogram Estimation Methods, Two-Step Joint Histogram Estimation, One-Step Joint Histogram Estimation, Interpolation Induced Artifacts, Generalized Partial Volume Estimation of Joint Histograms, Optimization Issues in the Maximization of MI

UNIT – IV
Independent Component Analysis: Introduction, Concept of ICA, ICA Algorithms, Pre-processing using PCA, Information Minimization Solution for ICA, ICA Solution through Non-Gaussianity Maximization, Application of ICA to Hyperspectral Imagery, Feature Extraction Based Model, Linear Mixture Model Based Model, An ICA algorithm for Hyperspectral Image Processing, Applications using ICA.
UNIT – V
Support Vector Machines : Introduction, Statistical Learning Theory, Empirical Risk Minimization, Structural Risk Minimization, Design of Support Vector Machines, Linearly Separable Case, Linearly Non-Separable Case, Non-Linear Support Vector Machines, SVMs for Multiclass Classification, One Against the Rest Classification, Pair wise Classification, Classification based on Decision Directed Acyclic Graph and Decision Tree Structure, Multiclass Objective Function, optimization Methods, Applications using SVM.

References:

1	Pramod K. Varshney, Manoj K. Arora, *"Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data"*, Springer Science & Business Media
2	S. Svanberg, *"Multi-spectral Imaging– from Astronomy to Microscopy",* from Radio waves to Gamma rays
3	Christopher Bishop, *"Pattern Recognition and Machine Learning",* Mcgraw-Hill

SMART SENSORS

OE 902

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Explain the operation/working of different sensors.*
2. *To get fundamental knowledge of sensors and transducers and their operating principles, for measurement of mechanical parameters.*
3. *To impart interdisciplinary knowledge regarding transducers, pneumatic actuators, hydraulic actuators and explain the operation of pressure, flow, and level transducers in context with applications.*

Outcomes: *At the end of this course, students will be able to:*

1. *After successfully completing the course students will be able to Applications and selection of sensors/transducers for particular Application.*
2. *Describe the various types of sensors including thermal, mechanical, electrical, electromechanical and optical sensors.*
3. *Select appropriate transducers and instrumentation system components for a specific application. Design and development of temperature/ pressure etc measurement systems.*
4. *Select appropriate Switches and final control elements for a specific application.*
5. *Selection of communication protocol and smart sensors for particular application.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Basics of Instrumentation Systems General Configuration and functional description of measuring instruments, static and dynamic characteristics of instruments, errors in instrumentation systems, active and passive transducers and their classification, fundamental standards and units for common physical parameters. Temperature, Flow and Level Sensing Temperature: Resistance temperature Detectors, thermistors, thermocouples and pyrometers.

UNIT – II

Position, Motion, Pressure and Force Sensors, Position and motion sensing: Potentiometers, LVDT, proximity sensors (inductive, capacitive and optical), absolute and incremental optical encoders, piezoelectric accelerometer. Pressure Sensors: LVDT as secondary transducer to measure pressure, Stress, Strain and Force: Strain Gauges and load cell. Level: Ultrasonic, Capacitance probe type, Hydrostatic pressure and Nuclear level detection techniques.

UNIT – III
Actuators and Final Control Elements Pneumatic and hydraulic actuators- Directional control valves, Pressure control valves, Cylinders, Process control valves - Electrical actuators- Mechanical switches, Solid state switches, Solenoids, DC motors, AC motors and Stepper motors.
UNIT – IV
Data Acquisition, Bus Standards and Protocols Multichannel data logging and computer based data acquisition system – RS 232C standard, IEEE 488 bus, I2C bus, HART protocol , Field bus technology - Foundation Field bus and Profibus.
UNIT – V
Semiconductor, MEMS and SMART Sensors Semiconductor temperature sensing – LM75 block diagram, temperature compensated, integrated phototransistor, Magnetic field sensors – Hall effect and magneto-resistive elements (MRE), magneto-transistors, piezoelectric (PZT) sensors and actuators. SMART sensors.

References:

1	W. Bolton; *"Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering"*, Pearson Education; 3rd Edition.
2	William C. Dunn, *"Introduction to Instrumentation, Sensors, and Process Control",* Artech House Sensors Library.
3	David G. Alciatore, Michael B Histand; "*Introduction to Mechatronics and Measurement"*
4	Ernest O. Doebelin, *"Measurement System Application and Design*", Mc-Graw Hill; 5th Edition.

MAJOR PROJECT PHASE - I

EC 281

Instruction: 20 periods per week *Duration of SEE: --*
CIE: 100 marks *SEE: --*
Credits: 10

Outcomes: *At the end of this course, students will be able to:*

1. Exposed to self-learning various topics.
2. Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.
3. Learn to write technical reports.
4. Develop oral and written communication skills to present.
5. Defend their work in front of technically qualified audience

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, Osmania University and Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

SEMESTER - IV

MAJOR PROJECT PHASE - II

EC 282

Instruction: 32 periods per week *Duration of SEE: --*
CIE: -- *SEE: 200 marks*
Credits: 16

Outcomes: *At the end of this course, students will be able to:*

1.	*Use different experimental techniques and will be able to use different software/ computational /analytical tools.*
2.	*Design and develop an experimental set up/ equipment/test rig.*
3.	*Conduct tests on existing set ups/equipment's and draw logical conclusions from the results after analysing them.*
4.	*Either work in a research environment or in an industrial environment.*
5.	*Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester - III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head, Osmania University and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS & Head, Osmania University (All together	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce

MICROWAVE AND RADAR ENGINEERING (MRE)

SEMESTER - I

ADVANCED ELECTROMAGNETIC ENGINEERING

EE 301

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To become familiar with the basic Electromagnetic Theory and Electromagnetic Theorems and concepts*
2.	*To acquaint with theoretical analysis of the characteristics of electromagnetic waves in a wide variety of Practical Mediums*
3.	*To aware commercially available EM Simulation Software*

Outcomes: *At the end of this course, students will be able to:*

1.	*Able to apply fundamental electromagnetic concepts in various applications*
2.	*Able elaborate Maxwell's Equations for complex electromagnetic media.*
3.	*Able to understand the resonators and radiation of antennas*
4.	*Able to derive the propagation parameters for electromagnetic waves in various practical mediums.*
5.	*Able to acquire the knowledge on EM Simulation Software*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Fundamentals- Review of Basic Electromagnetic Theory, Maxwell's equations, Wave Equation, Time-Harmonic Fields, Plane waves in lossless and lossy media, Poynting's Theorem, Reflection and Transmission of waves.
UNIT – II
Theorems and Concepts- The Generalized Current Concept, Circuit-Field Relations, Auxiliary Vector potentials, The source concept, Duality, Uniqueness, Image Theory, The Equivalence Principle, Induction and Reciprocity theorems, Green's Functions.
UNIT – III
Guidance of Waves in Rectangular Cross section -The Parallel Plate Waveguide, The Rectangular Waveguide, Partially Filled Waveguide, The Dielectric Slab Guide, Surface Guided Waves.
UNIT – IV
Guidance of Waves in Circular Cross section - Circular wave guide, Radial wave guide.

Resonance of Waves- Resonators, Radiation of waves-Antennas.
UNIT – V
Introduction to Metamaterials, EBG Structures and Frequency Selective Surfaces, Survey of Commercially available EM Simulation Software.

References:

1	R.F.Harrington, "*Time-Harmonic Electromagnetic Fields",* McGraw-Hill, 1961, reissued by IEEE Press, 2001.
2	C.A.Balanis, "*Advanced Engineering Electromagnetics"*, John Wieley & Sons, 1989.
3	R.E.Collin, "*Field Theory of Guided Waves*", IEEE Press, 1991, 2nd Ed.
4	J.A.Kong, "*Electromagnetic wave Theory*", EMW Publishing, 2005, 2008.

MICROWAVE ANTENNAS

EC 302

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To familiarize the basic concepts of antenna parameters and radiation mechanism.*
2. *To analyze aperture antennas with the knowledge of various theorems and study the principles of frequency independent antenna design.*
3. *To understand, analyze and synthesize array antennas and also know the concepts of smart antennas*

Outcomes: *At the end of this course, students will be able to:*

1. *Able to understand different types of aperture antennas with the help of basic antenna fundamentals.*
2. *Able to understand the operating principles of microwave antennas.*
3. *Able to apply the knowledge in the design of various microwave aperture antennas.*
4. *Able to acquire basic knowledge of printed antennas*
5. *Able to acquire basic knowledge of smart antenna design*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Fundamental parameters and definitions for antennas, Theories of radiation, Image theory, Schelkunoff's equivalence theorem, Huygens' principle, Babinet's principle.
UNIT – II
Radiation from rectangular and circular apertures, design considerations, Fourier transform method in aperture antenna theory. Broadband antenna concept, Log periodic antennas, Frequency independent antennas.
UNIT – III
Linear arrays: Uniform and Non uniform amplitude distribution, Planar arrays, Synthesis of antenna arrays using Schelkunoff polynomial method, Fourier transform method and Woodward-Lawson method.
UNIT – IV
Printed antennas: Rectangular and circular patch antenna design, Feeding techniques for micro strip antennas, Methods of analysis, Printed antenna arrays, Bandwidth enhancement techniques, Compact and Tunable microstrip antenna.
UNIT – V
Concept and benefits of smart antennas, Types of smart antennas, Beam forming techniques,

Smart antenna methods, Algorithms.

[PTO]

References:

1	Constantine Balanis, *"Modern Antenna Handbook*", John wiley, 2008.
2	Stutzman, W.L. and Thiele, H.A., *"Antenna Theory and Design"*, 2nd Ed., John Wiley & Sons.
3	Bahl IJ, and Bhartia, *"Microstrip Antennas",* Artech House, 1982.
4	D.G.Fang , "*Antenna Theory and Microstrip Antennas",* CRC press 2010
5	James.JR.Hall PS.wood.C., "*Micro strip Antenna-Theory and Design*", Peter Peregrinu.1981

PROGRAM SPECIFIC ELECTIVE - I

MICROWAVE MEASUREMENTS

EC 311

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To understand and gain knowledge about measurement of wave length and Frequency of microwave signals.*
2. *To understand and gain knowledge about the use of microwave test bench in analyzing various types of microwave measurements and knowledge about measurement of microwave power.*
3. *To understand and gain knowledge about measurements on passive microwave components and Network analyzer*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand functional blocks involved in Microwave Measurements such as test sets, couplers and other components.*
2. *Understand Network Analyzer principle, Reflection and Transmission measurements using vector network Analyzer.*
3. *Understand measurements of Antenna radiation pattern and gain.*
4. *Understand measurements of Antenna Far-field and Near-field techniques.*
5. *Understand the methods and limitation of different microwave parameters measurement.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Measurement of wave length and Frequency, equivalent circuit of cavity wave meters. Typical wave meters, Resonant cavities. Methods of frequency measurements-Direct measurement – Interpolation method.
UNIT – II
Measurement of reflection coefficient Low, high, medium VSWR measurements. Standing wave pattern, Slotted line section and its limitation. Impedance measurement techniques. Nodal shift method. Tangent method. Reflectometer.

UNIT – III
Measurement of microwave power: Typical barater elements, thermistor. Bolometer bridge circuits, extending range of bolometer devices, low and high-power measurement techniques.
UNIT – IV
Measurement of attenuation: insertion loss method. Substitution method. Measurement of S-parameters. Network Analyser principle. Reflection and Transmission measurements using vector network Analyser.
UNIT – V
Measurements on passive microwave components. Characteristics of directional coupler. Isolator, Circulator. Antenna Measurements. Measurements of radiation pattern, Antenna gain measurements. Far field and Near field techniques.

References:

1	Ginzton, EL., *"Microwave Measurements"*, McGraw Hill
2	Sucher & Fox., *"Microwave Measurements"*. Vol.I, II, III.
3	Montgemery. Cc., *"Techniques of Microwave Measurements*", Radiation Lab Series

MICROWAVE SEMICONDUCTOR DEVICES

EC 312

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To understand Schottky Barrier Diode, IMPATT & TRAPATT diodes: Principles and applications as amplifiers and oscillators.*
2.	*To understand PIN diodes working principle and its applications as Switches, limiters, phase shifters and modulators.*
3.	*To analyze Avalanche Transit-Time Devices and its applications in microwave amplifiers and oscillators and understand operating characteristics of MISFETs, MESFETs GaAs FETs and BJTs and their applications*

Outcomes: *At the end of this course, students will be able to:*

1.	*Understand the working principles of the Microwave solid state devices (Tunnel Diode, PIN Diode, Schottky Barrier Diode ...etc.)*
2.	*Choose a suitable microwave solid state device for a particular application.*
3.	*Understand the use of Tunnel Diode and Gun Diode in microwave amplifiers.*
4.	*Understand the use of PIN diodes in microwave applications- Switches, limiters, phase shifters and modulators.*
5.	*Understand operating characteristics of MISFETs, MESFETs, GaAs FETs and BJTs and their applications.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Transient and ac behavior of p-n junctions, effect of doping profile on the capacitance of p-n junctions, noise in p-n junctions, high-frequency equivalent circuit. Varactor diode: Equivalent circuit, static and dynamic figures of merit Manley Rowe power relation. Parametric amplifiers. Up converter, Degeneration amplifiers, Varactor multipliers. Charge storage capacitance.

UNIT – II

Tunnel diode: equivalent circuit. Tunnel diode stability, Tunnel diode amplifiers. Gunn devices: Volt amp. Characteristics, Small signal, Nonlinear, large signal theory, Modes of operation of Gunn diode, Gunn amplifiers-Gunn oscillators, Avalanche transit time MW diodes. Small signal theory, Large signal operation, Noise.

UNIT – III
PIN diodes: Description, the I-layer. Equivalent circuit behavior under reverse bias and forward bias. Diode impedance. Materials. Applications- Switches, limiters, phase shifters and modulators.
UNIT – IV
Schottky Barrier Diode: Physics of Schottky barriers. Design of and performance of Schottky barrier diode applications. IMPATT & TRAPATT diodes: Principles and applications as amplifiers and oscillators.
UNIT – V
High frequency limitations of BJT, microwave bipolar transistors, heterojunction bipolar transistors; GaAs FETs, low noise and power GaAs FETs and their applications. DC biasing and impedance matching. Microwave transistor 'S' parameters. Operating characteristics of MISFETs and MESFETs, short-channel effects, high electron mobility transistor.

[PTO]

References:

1	S.Y.Liao, *"Microwave Devices and Circuits"*, Third addition, Prentice Hall.
2	Watson, "*Microwave Semiconductor Devices and their applications",* McGraw Hill,1969.
3	Sze, S.M., and Ng, K.K., *"Physics of Semiconductor Dev ices"*, 3rd Ed., wiley-Interscience,2006
4	Golio, M., *"RF and Microwave Semiconductor devices Handbook",* CRC Press (2002)

WIRELESS AND MOBILE COMMUNICATIONS

EC 114

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *An overview of key wireless technologies: Various generations of mobile communications for voice and data, cordless, paging, fixed and mobile broadband wireless systems, and beyond*
2. *Wireless system design fundamentals: channel assignment, handoffs, interference, frequency reuse, capacity planning, large-scale fading, and Outdoor, Indoor propagation models and Path loss, small-scale fading, multipath, reflection, diffraction, scattering and Various statistical models for small-scale fading study*
3. *Various Diversity techniques, Equalizers used in communication receivers, Multiple Access techniques and their applications in wireless networks*

Outcomes: *At the end of this course, students will be able to:*

1. *Develop design models for cellular systems.*
2. *Analyze the various Large-scale fading effects in designing propagation models for Mobile communications in Outdoor environments.*
3. *Analyze the various types of Small-scale fading, measurement techniques, Parameters of multi-path radio and Statistical models.*
4. *Understand Various Diversity techniques and Equalizers used in communication receivers.*
5. *Develop the design models for various multiple access techniques and understand their spectral efficiencies.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction to Wireless Communication Systems and the Cellular Concept
Evolution of Mobile Radio Communications, Examples of Wireless Communication Systems, Overview of 1G,2G, 2.5 G,3 G, 4G and 5G Cellular networks.
The Cellular Concept: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Improving Coverage and Capacity in cellular systems.

UNIT – II
Mobile Radio Propagation: Large-Scale Path Loss: Introduction to Radio wave propagation, Free space propagation model, Relating Power to Electric Field, the three basic propagation mechanisms- Reflection, Ground Reflection (Two Ray) model, Diffraction, Scattering. *Outdoor propagation models:* Longley-Rice model, Okumura model, Hata model, PCS Extension to Hata model, Walfisch and Bertoni Model, Wideband PCS Microcell model. *Indoor propagation models:* Partition losses (same floor), Partition losses between floors, Log-distance path loss model, Ericsson multiple breakpoint model, Attenuation factor model, and Signal penetration into buildings.
UNIT – III
Mobile Radio Propagation: Small Fading and Multipath: Small scale multipath propagation, Factors influencing small scale fading, Doppler shift, Small scale multipath Measurements-Direct RF Pulse System, Spread Spectrum Sliding correlator Channel Sounding, Frequency Domain Channels Sounding, Parameters of Mobile multipath channels, Types of Small Scale Fading, Statistical models for multipath Fading Channels-Clarke's model for flat fading, spectral shape due to Doppler, Level Crossings and Fading Statistics, Two-ray Rayleigh Fading model.
UNIT – IV
Equalization and Diversity: Introduction, Fundamentals of Equalization, Training a Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Nonlinear Equalization-Decision Feedback Equalization (DFE), Maximum Likelihood Sequence Estimation (MLSE) Equalizer, Algorithms for adaptive equalization *Diversity Techniques*: Practical Space Diversity Considerations, Selection Diversity, Scanning Diversity, Maximal Ratio Combining, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver.
UNIT – V
Multiple Access Techniques for Wireless Communications: FDMA, TDMA, Spread Spectrum Multiple Access- FHMA and CDMA, SDMA, Spectral efficiency analysis for Multiple Access Technologies: FDMA, TDMA and CDMA Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas.

References:

1	Theodore, S. Rappaport, *"Wireless Communications, Principles and Practice"*, 2nd Ed.,2002, PHI publication.
2	2. Andrea Goldsmith, *"Wireless Communications*", 2005, Cambridge University Press.
3	Kaveh pah Laven and P.Krishna Murthy, *"Principles of Wireless networks",* 2002,PE.
4	P.Nicopolitidis, M.S.Obaidat, G.I.Papadimitriou, A.S.Pomportsis, *"Wireless Networks"*, 200, John Wiley & Sons Pte Ltd.
5	Ashok Raj, *"Wireless Communication*", First Edition, 2014, Khanna Publishers.

PROGRAM SPECIFIC ELECTIVE - II

SATELLITE RADIO NAVIGATION

EC 313

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To explore the basics of Satellite Communications.
2. To sensitize about the GNSS signal structure, errors and the RINEX data.
3. To analyse other GNSS constellations and SBAS.

Outcomes: *At the end of this course, students will be able to:*

1. Understand the properties of Satellite systems.
2. Study about the GPS and various coordinate systems.
3. Estimate the various GPS errors and DoPs
4. Explore the RINEX data formats and DGPS principles
5. Analyse the operation of GNSS, SBAS and LAAS

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Review of Satellite Communications: Brief History of Satellite Communications and its properties**,** Orbits, Keplers Laws and Orbital parameters, Earth stations and their types, Mechanics of Lunching a synchronous satellite, Satellite launch, launch vehicles and their comparison.

UNIT – II

GPS fundamentals: INS, Trilateration, Transit: advantages and its limitations, GPS principle of operation, and its operating frequencies, Solar and Sidereal days, GPS and UTC Time. GPS Signals: Signal structure, C/A and P-Code, ECEF and ECI coordinate systems and WGS 84 and types of GPS Receivers, link budget.

UNIT – III

GPS Error: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, multipath; estimation of Total Electron Content (TEC) using dual frequency measurements, Various DOPs, Spoofing and Anti-spoofing: Future GPS satellites, new signals and their benefits.

UNIT – IV
*GPS data processing and DGPS***:** RINEX Navigation and Observation data formats, Ambiguity resolution, cycle slips, Position estimation, Principle of operation of DGPS, architecture and errors.
UNIT – V
Other Constellations and Augmentation systems Other Satellite navigation constellations, Relative advantages of SBAS and GBAS, Wide Area Augmentation System (WAAS) architecture, its operation, advantages and limitations, GAGAN, EGNOS and MSAS, Local Area Augmentation System (LAAS): Operation, advantages, limitations and applications.

References:

1	B.Hofmann Wollenhof, H.Lichtenegger, and J.Collins, *"GPS Theory and Practice",* Springer Wien, new York, 2000.
2	Pratap Misra and Per Enge, *"Global Positioning System Signals, Measurements, and Performance,"* Ganga-Jamuna Press, Massachusetts, 2001.
3	Ahmed El-Rabbany, "*Introduction to GPS,"* Artech House, Boston, 2002.
4	Bradford W. Parkinson and James J. Spilker, *"Global Positioning System: Theory and Applications,*" Volume II, American Institute of Aeronautics and Astronautics, Inc., Washington, 1996.
5	Elliot D. Kaplan, *"Understanding GPS Principles and Applications*", Artech House Boston,1996.
6	A.Leick, *"GPS Satellite Surveying*", John Wiley and sons, 1990.

RF MEMS

EC 314

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To impart knowledge on basics of MEMS and their applications in RF circuit design
2. To study and understand various switching parameters and MEMS switch design process
3. To know the how best the miniaturized antennas can be designed using MEMS technology

Outcomes: *At the end of this course, students will be able to:*

1. Understand the Concept of miniaturization and the need of MEMS in various applications
2. Understand the concepts of various actuation mechanisms of MEMS
3. Know the fundamental and technological possibilities and constraints when designing and implementing RF MEMS subsystems.
4. Know the antenna design techniques using MEMS technology
5. Understand Micro fabrication techniques

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Microelectromechanical Systems (MEMS) And Radio Frequency MEMS: Introduction – Microfabrication for MEMS – Electromechanical transducers – Microsensing for MEMS – Materials for MEMS. MEMS Materials and Fabrication Techniques: Metals – Semiconductors – Thin films for MEMS and their deposition techniques – Materials for polymer MEMS – Bulk micromachining for silicon-based MEMS – Silicon surface micromaching – Microstereo lithography for polymer MEMS.
UNIT – II
RF MEMS Switches: Introduction – Switch parameters – Basics of switching – Switches for RF and microwave applications – Electrostatic switching – Approaches for low-actuation –voltage switches – thermal switching. Bistable micro relays and microactuators. –MEMS switch design, modeling and evaluation –MEMS switch design considerations.MEMS Inductors and Capacitors: Introduction – MEMS inductors – MEMS capacitors.
UNIT – III
Micromachined RF Filters and Phase Shifters: Introduction – Modeling of mechanical filters -

Micromechanical filters –Micromachined phase shifters: Introduction – Types of phase shifters and their limitations – MEMS phase shifters.
UNIT – IV
Micromachined Antenna: Introduction - Overview of microstrip antenna – Micromachining techniques to improve antenna performance – Micromachining as a fabrication process for small antenna – Micromachined reconfigurable antenna.
UNIT – V
Micromachined Transmission Lines and Components: Introduction – Micromachined transmission lines and components – Design, fabrication and measurements. Integration and Packaging for RF MEMS Devices: Role of MEMS packages, Types of MEMS packages, Multichip module packaging, Reliability issues, Thermal issues.

References:

1	Vijay K Varadan, Vinoy K J and Jose K A, *"RF MEMS and Their Applications* ", Published by John Wiley & Sons Ltd, England, reprinted April 2003.
2	Gabriel M Rebeiz, *"RF MEMS Theory, Design and Technology"*, John Wiley & Sons Ltd, New Jersey, 2003.
3	Hector J De Los Santos, *"RF MEMS Circuit Design for Wireless communications",* Artech House, 2002.

COMPUTATIONAL ELECTROMAGNETICS

EC 315

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To understand the basics of finite difference methods for solving Maxwell equations, both static and electrodynamics*
2. *To understand the basics of finite element methods for solving scalar Helmholtz equation.*
3. *To understand the determination of Green's function.*

Outcomes: *At the end of this course, students will be able to:*

1. *Able to utilize contemporary numerical approaches in Electromagnetics.*
2. *Able to formulate, and solve engineering problems related to RF-microwave circuits.*
3. *Able to formulate, and solve engineering problems of high-speed interconnects and MEMS, antenna analysis and design.*
4. *Able to apply Green's functions for free space and transmission lines,*
5. *Able to apply Green's functions for waveguides, and microstrips.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Fundamental Concepts: Integral equations versus differential equations, radiation and edge conditions, modal representation of fields in bounded and unbounded media.
UNIT – II
Green's Functions: Green's function technique for the solution of partial differential equations, classification of Green's functions, various methods for the determination of Green's functions including Fourier transform technique and Ohm-Rayleigh technique, dyadic Green's functions, determination of Green's functions for free space, transmission lines, waveguides, and microstrips.
UNIT – III
Integral Equations: Formulation of typical problems in terms of integral equations: wire antennas, scattering, apertures in conducting screens and waveguides, discontinuities in waveguides and microstrip lines; Solution of Integral equations: General Method of Moments (MoM) for the solution of integro-differential equations, choice of expansion and weighting functions, application of MoM to typical electromagnetic problems.

UNIT – IV
Finite Element Method: Typical finite elements, Solution of two-dimensional Laplace and Poisson's equations, solution of scalar Helmholtz equation.
UNIT – V
Finite-difference Time-domain Method: Finite differences, finite difference representation of Maxwell's equations and wave equation, numerical dispersion, Yee's finite difference algorithm, stability conditions, programming aspects, absorbing boundary conditions.

References:

1	Peterson, A.F, Ray, S.L. and Mittra, R., "*Computational Methods for Electromagnetics*", Wiley-IEEE Press. 1998
2	Harrington, R.F., "*Field Computation by Moment Methods*", Wiley- IEEE Press. 1993.
3	Sadiku, M.N.O., "*Numerical Techniques in Electromagnetics*", 2nd Ed., CRC Press-2.
4	Ramesh Garg,**"** Analytical *and Computational Methods in Electromagnetics*" House,2008.

RESEARCH METHODOLOGIES IN ECE

EC 100

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To know the motivation on research philosophy and processes in general.
2. To be able to formulate the problem statement and prepare research plan for the problem under investigation through literature.
3. To be able to apply various techniques for data analysis and patenting

Outcomes:

1. Students able to understand research methodology and problems
2. Able to define the techniques involved in defining problem
3. Able to Developing a Research plan and research set up
4. Able to analyze the collection of data and statistical analysis
5. Able to have knowledge on writing the report and patenting

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Objectives and Types of research: Objectives and Motivation of research- types of research-Research approaches – Significance of Research-Research Methods versus Methodology-Research and Scientific method- Importance of research methodology – Research process-criteria of good research- Problems encountered by Researchers in India-benefits to society in general.
UNIT – II
Research formulation: Defining and formulating the research problem, selecting the problem, importance of literature review in define a problem, literature review, primary and secondary sources, reviews, monograms, patents, research data bases web as a source, identifying gap areas from literature review and research data bases, devilment of working hypothesis
UNIT – III
Research Design and methods: Meaning of research design - need of research design- features of a good design- important concepts relating to research design- different research designs-Basic Principles of experimental designs- Developing a Research plan-Exploration, descriptions diagnosis and experiment

UNIT – IV
Execution of the research and data collection: Aspect of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis, strategies and tool, data analysis with statistical packages (sigma STAT, SPSS for student test t-test, ANOVA, etc.) hypothesis testing, generalization and interpretation.
UNIT – V
Reporting and thesis writing: Structure and components of scientific reports, types of report, technical report and thesis. Thesis writing-different steps and software tools (word processing) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, illustrations and tables, bibliography, referencing and footnotes. Use of visual aids. *Patenting:* The Basics of the Patent System, Patent Law, How to Read a Patent, Protecting Invention and Planning Patent Filing, Preparing Patent Application

References:

1	C.R.Kothari, "*Research methodology, Methods & technique*", New age international publishers, 2004.
2	R.Ganesan, "*Research Methodology for Engineers*", MJP Publishers: Chennai, 2011.
3	P.Ramdass and A.Wilson Aruni, *"Research and Writing across the disciplines",* MJP Publishers, Chennai 2009
4	Matthew Y Ma, "Fundamentals of Patenting and Licensing for Scientists and Engineers" 2nd Edition 2015

AUDIT COURSE-I
ENGLISH FOR RESEARCH PAPER WRITING

AC 101

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*Understand that how to improve your writing skills and level of readability*
2.	*Understand the nuances of language and vocabulary in writing a Research Paper.*
3.	*Develop the content, structure, format of writing a research paper and produce original research papers without plagiarism*

Outcomes: *At the end of this course, students will be able to:*

1.	*Interpret the nuances of research paper writing.*
2.	*Differentiate the research paper format and citation of sources.*
3.	*To review the research papers and articles in a scientific manner.*
4.	*Avoid plagiarism and be able to develop their writing skills in presenting the research work.*
5.	*Create a research paper and acquire the knowledge of how and where to publish their original research papers*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.
UNIT – II
Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.
UNIT – III
Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.
UNIT – IV
Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing - The final draft and proof reading.
UNIT – V
Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications –

Advantages/Benefits *Presentation Skills:* Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

References:

1	C. R Kothari, Gaurav, Garg, "*Research Methodology Methods and Techniques*", 4/e, New Age International Publishers.
2	Day R, "*How to Write and Publish a Scientific Paper"***,** Cambridge University Press, 2006
3	"*MLA Hand book for writers of Research Papers*", 7/e, East West Press Pvt. Ltd, New Delhi
4	Lauri Rozakis, Schaum's, "*Quick Guide to Writing Great Research Papers"*, Tata McGraw Hills Pvt. Ltd, New Delhi.

SANSKRIT FOR TECHNICAL KNOWLEDGE

AC 102

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*To get a working knowledge in illustrious Sanskrit, the scientific language in the world*
2.	*To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects*
3.	*To explore the huge knowledge from ancient Indian literature*

Outcomes: *At the end of this course, students will be able to:*

1.	*Develop passion towards Sanskrit language*
2.	*Decipher the latent engineering principles from Sanskrit literature*
3.	*Correlates the technological concepts with the ancient Sanskrit history.*
4.	*Develop knowledge for the technological progress*
5.	*Explore the avenue for research in engineering with aid of Sanskrit*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)
UNIT – II
Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series). The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).
UNIT – III
Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering): Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower- Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)
UNIT – IV
Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vedic

command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.
UNIT – V
Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthi yanthram

References:

1	M Krishnamachariar, "*History of Classical Sanskrit Literature",* TTD Press, 1937.
2	M.R. Kale, "*A Higher Sanskrit Grammar: For the Use of School and College Students*", Motilal Banarsidass Publishers, 2015.
3	Kapail Kapoor, "*Language, Linguistics and Literature: The Indian Perspective",* ISBN-10: 8171880649, 1994.
4	"*Pride of India*", Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5	Shri Rama Verma, "*Vedas the source of ultimate science",* Nag publishers, 2005.

VALUE EDUCATION

AC 103

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*Understand the need and importance of Values for self-development and for National development.*
2.	*Imbibe good human values and Morals*
3.	*Cultivate individual and National character.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Gain necessary Knowledge for self-development*
2.	*Learn the importance of Human values and their application in day to day professional life.*
3.	*Appreciate the need and importance of interpersonal skills for successful career and social life*
4.	*Emphasize the role of personal and social responsibility of an individual for all-round growth.*
5.	*Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.

UNIT – II

Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT – III

Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.

UNIT – IV

Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy

books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.
UNIT – V
Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

References:

1	Chakroborty, S.K., *"Values & Ethics for organizations Theory and practice*", Oxford University Press, New Delhi, 1998.
2	2. Jaya Dayal Goyandaka, "*Srimad Bhagavad Gita with Sanskrit Text*", Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur, 2017.

CONSTITUTION OF INDIA

AC 104

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective*
2. *To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role*
3. *Entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*

Outcomes: *At the end of this course, students will be able to:*

1. *Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.*
2. *Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.*
3. *Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru*
4. *The eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.*
5. *Discuss the passage of the Hindu Code Bill of 1956.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.
UNIT – II
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
UNIT – III
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT – IV
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
UNIT – V
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

1	*"The Constitution of India",* 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, *"Dr. B. R. Ambedkar framing of Indian Constitution",* 1st Edition, 2015.
3	M. P. Jain, "*Indian Constitution Law",* 7th Edn., Lexis Nexis, 2014.
4	D.D. Basu, *"Introduction to the Constitution of India",* Lexis Nexis, 2015.

MICROWAVE SYSTEMS LABORATORY-I

EC 351

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1. *To become familiar with microwave bench set up and source characterization.*
2. *To understand the antenna radiation characteristics determination using microwave bench setup, and understand the analog and digital communication using fiber optic cables.*
3. *To study and explore various parameters of GNSS using GNSS receivers.*

Outcomes: *At the end of this course, students will be able to:*

1. *Able to demonstrate the characteristics of Microwave sources.*
2. *Able to Energize microwave bench and study the characteristics of antenna impedance*
3. *Able to understand the principles of optical fiber communications.*
4. *Able to measure the radiation pattern characteristics of Horn antenna and power characteristics of frequency scanned array antenna*
5. *Study and estimate various important parameters of different Satellite navigation constellations.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Cycle -I

Experiments:

1. Microwave source characteristics-Reflex Klystron and Gunn oscillator
2. S-parameter Measurement of Microwave Passive devices
3. Radiation Pattern of Horn Antenna
4. Waveguide Discontinuities-Inductive and capacitive Diaphragms
5. Communication through Optical Fiber

Cycle - II

List of experiments:

1. Study of Hardware and Software aspects of Dual Frequency IGS (IRNSS/GPS/SBAS) Receiver.

2. Tracking and analysis of Standalone IRNSS and GPS satellites using IGS receiver in terms of Satellite visibility.
3. Estimation of True Range from Satellite to receiver for all the visible IRNSS satellites.
4. Conversion of geographic cartesian to geodetic coordinate's transformation of GPS and GALILEO constellations.
5. Study of Hardware and Software aspects and getting acquaintance with Triple frequency GPStation6 receiver.
6. Study of Hardware and Software aspects of NAVLAN IG3 Single frequency IRNSS/GPS/GLONASS Receiver.
7. Tracking and analysis of Standalone BeiDou satellites using GPStation6 receiver.

Note: The experiments will be decided and modified if necessary and conducted by the teacher concerned.

SEMINAR – I

EC 361

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Outcomes: *At the end of this course, students will be able to:*

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

SEMESTER - II

MICROWAVE CIRCUITS AND SYSTEMS

EC 303

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To become familiar with the characterization of microwave networks*
2. *To acquaint with theoretical analysis of the characteristics of electromagnetic waves in planar transmission lines.*
3. *To know impedance matching concepts and to become familiar with microwave passive circuit analysis and design*

Outcomes: *At the end of this course, students will be able to:*

1. *Able to Characterize the reciprocal networks, lossless networks in terms of S-Parameters*
2. *Able to understand the behavior of most commonly used planar transmission lines such as microstrip line and strip line etc.*
3. *Able to Design impedance matching networks*
4. *Able to understand the operation and design of passive microwave devices such as power dividers, couplers and filters*
5. *Able to understand the microwave propagation in ferrites and use them in various applications*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to micro wave Circuit concept: one port junction. scattering matrix. Properties of [s]matrix, Relationship between [s], [z]and[y] parameters. Wave amplitude transmission matrix[A]. Relation between [A] and [s].
UNIT – II
Analysis of microstrip line and strip line. Method of conformal Transformation. Characteristic parameters of Microstrip, strip lines. Introduction to slot line and coplanar waveguide. Impedance matching: Stub matching- Single and double stub using Smith chart solutions, Quarter wave transformer, Multi section transformer design, tapered lines- Exponential taper, triangular taper.
UNIT – III
Introduction to Coupled Microstrips, Even and odd mode analysis. Theory of coupled

microstrip Directional couplers. Calculations for a coupled pair of Microstrips. Branch line couplers. Eigenvalue method and its applications to branch line couplers, hybrid ring couplers and the Wilkinson power dividers/combiners
UNIT – IV
Lumped Elements for MIC‟s Design and fabrication of lumped elements, circuits using lumped elements Impedance transformers. *Microwave Planar Filters*: Periodic structures, Filter design by the Image Parameter method, Filter design by the Insertion Loss method, Filter transformations, and Filter implementation.
UNIT – V
Micro wave propagation in ferrites. Principles of faraday rotation. Microstrip on Ferromagnetic substrates, Microstrip circulators. Isolators and phase shifters. Applications of MIC‟s.

References:

1	Collins. RE, "*Foundations for Microwave Engineering"*, McGraw Hill, 2nd edn, 1992.
2	Pozer.DM, *"Microwave engineering",* 2nd edn. John Wiley andsons, inc.,1999.
3	Gupta KC, and Amarjit Singh, "*Microwave Integrated circuits",* Wiley Eastern, 1974.
4	Hoffman R.K., *"Hand Book of Microwave integrated Circuits*", Artech House, Boston, 1987.

PRINCIPLES OF RADAR ENGINEERING

EC 304

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To familiarize the basic concepts of a radar system in target detection.
2. To know the features radar target models and clutter.
3. To understand various types of radar systems and their applications.

Outcomes: *At the end of this course, students will be able to:*

1. Able to understand the radar fundamentals.
2. Able to understand the principle of operation of various radar systems.
3. Able to apply the knowledge in the design of a radar system
4. Able to characterize the target fluctuation
5. Able to understand the concepts of phased array radar

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
The radar range equation: Radar fundamentals, Derivation of range equation, Search radar equation, Jamming and radar range with jamming, Radar clutter and radar range with clutter.
UNIT – II
The theory of target detection: Noise and false alarms. Detection of one sample of signal with noise, Integration of pulse trains, Detection of fluctuating targets, CFAR, Optimum and matched filter Theory, Loss factors in detection.
UNIT – III
Targets and interference: Definition of radar cross section, Radar cross section of simple and complex objects, Spatial distribution of cross section. Bistatic cross section. CW and FM Radar: Doppler Effect. CW and FMCW Radar, Airborne Doppler Navigation, Multi frequency CW Radar.
UNIT – IV
MTI Radar: Delay line cancellers, Sub clutter Visibility, MTI using range gates and filters, Pulse Doppler radar, Non-coherent MTI radar, Tracking Radar: Different types of tracking techniques. Tracking in range, Tracking in Doppler. Search Acquisition radar, Comparison of Trackers.

UNIT – V
Electronically steered phased array antenna in radar: Basic concepts, Phase shifters, Frequency scan arrays, Array elements, Feeds for arrays, Simultaneous multiple beams from array antennas.

References:

1	David barton .k, *"Modern radar system analysis*", Artech house, 1988.
2	Fred nathanson e, *"Radar design principles signal processing and the environment*", McGraw Hill.1969.
3	Cook CE. Bernfield. M, *"Radar signals*" Academic press, 1967.
4	Skolnik, *"Introduction to radar systems*", McGraw hill, 2nd Edition 2003.

PROGRAM SPECIFIC ELECTIVE - III

SATELLITE AND MICROWAVE COMMUNICATIONS

EC 316

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To explain the basic principle involved in a transmission system.*
2. *To make the students to understand about Tropospheric scatter communication system and the Earth Station Technology*
3. *Highlight the importance of Mobile Satellite Communications and demonstrate the concepts related to Future Trends in Satellite Communication*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand the principle and operation of transmission system.*
2. *Understand about Tropospheric scatter communication system*
3. *Estimate the significance of Earth Station Technology.*
4. *Use Mobile Satellite Communications in various applications.*
5. *Understand the new trends in Satellite communication*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introductory concepts: Transmission problem, simplified transmission system, the decibel and basic derived decibel unit, Neper, practical transmission, speech, SNR, Noise figure and noise temperature, CCITT modulation plan.
UNIT – II
LOS and Tropospheric scatter communication system: Link engineering, propagation characteristics in free space, Introduction to Tropospheric scatter communication system, phenomenon of tropospheric scatter, tropospheric fading, path loss calculations,
UNIT – III
Earth Station Technology: Introduction, Elements of an Earth Station, Types of Earth Stations, Equipment Reliability and Space Qualification, Redundancy.
UNIT – IV
Mobile Satellite Communications- Introduction, International Maritime Satellite (INMARSAT), and Mobile satellite Communications with Non-Geo Satellite, VSAT Systems: VSAT Network Configurations, VSAT System Elements, Advantages and Applications of VSAT Systems.

UNIT – V
Modern Developments and Future Trends-Introduction, Micro and Nano Satellites, Satellite Laser Communication, Air-Craft launching, Orbital refueling, Deep Space Communication, GNSS.

[PTO]

References:

1	Roger L Free man, *"Telecommunication transmission handbook*", John Wiley, 4th Edition, 1998.
2	T.Pratt & C.W. Bostian, *"Satellite Communication Systems"*, PHI, 1st edition, 1986.
3	B.G.Evans, "*Satellite communication system edited",* 3rd edition, IET, U.K., 2008.
4	Dennis Roddy, *"Satellite Communication Systems"*, Mc Graw Hill publications, 4th Edition, 2006.
5	Wayne Tomasi, *"Advanced Electronics Communication System",* Pearson Education, 6th Edt, Apr 2003.

PHASED ARRAY RADAR

EC 317

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To understand the principle of electronic scanning and its application to a phased-array radar system*
2. *To understand the concepts of cell, grid and feeding techniques.*
3. *To familiarize with the design of frequency scanned array and concepts of beam positioning*

Outcomes: *At the end of this course, students will be able to:*

1. *Able to understand the basic concepts of radar beam steering and determine the direction of a resultant beam.*
2. *Able to understand the advantage and applications of an electronically scanned system.*
3. *Able to understand the concepts of frequency scanned array*
4. *Able to understand the role of phase shifters and feed networks in the frequency scanned array design.*
5. *Able to design planar array antenna with scanning capabilities*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Conventional scanning techniques, Mechanical versus electronic scanning, Techniques of Electronic scanning, Frequency, Phase and time delay scanning principle, Hybrid scanning techniques.
UNIT – II
Array Theory, Linear and Planner arrays, various grid configuration, Concept of cell and grid, Calculation of minimum number of elements, Radiation pattern, Grating lobe formation, Rectangular and triangular grid design of arrays.
UNIT – III
Feed Networks for phased Arrays, Corporate Feed, Lens and Reflect feed Techniques, Optimum f/d ratio basic building block for corporate feed network, Series, Parallel feed networks, Comparison of various feeding techniques, Antenna Array Architecture, Brick/ Tile Type construction
UNIT – IV
Frequency scanned array design, Snake feed, Frequency-phase scanning, Phase scanning,

Digital phase shifter PIN diode and Ferrite phase shifters for phased arrays, Beam pointing errors due to digitalization, Beam pointing accuracy.
UNIT – V
Search patterns, Calculation of search frame time, Airborne phased array design, Electronic scanning radar parameter calculation, Application of phased arrays, Phased Array Radar Systems, Active Phased Array, TR/ATR Modules.

References:

1	Olliner & knittel, "*Phased Array Radar",* Artech House, 1972.
2	Kahrilas, PJ, *"Electronic Scanning Radar Systems Design Handbook*", Artech House, 1976.
3	Skolnik, MI, *"Radar Handbook",* Mcgraw Hillso, NY, 1970.
4	Hansen, RC, *"Significant Phased Array"* Papers.
5	Galati,G, *"Advanced Radar Technique and Systems",* Peter Peregrims Ltd, London, 1993.

AD-HOC WIRELESS NETWORKS

EC 318

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *An overview of ad hoc wireless networks, issues and applications.*
2. *The design issues of MAC layered protocols for adhoc networks and finding the solutions and various routing mechanisms for adhoc wireless networks*
3. *Designing issues at Transport layer of wireless network model and study of network security issues, key management and their solutions.*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand the various ad hoc wireless networks and their standards.*
2. *Know the design issues and applications of various ad hoc wireless networks.*
3. *Analyze and design the MAC protocols for different applications of adhoc wireless networks.*
4. *Analyze and design different routing protocols for different adhoc networks.*
5. *Know and analyze the transport layered issues and security management for adhoc networks.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Ad-hoc Wireless Networks: Fundamentals of Wireless Communication Technology, Characteristics of the Wireless Channel, IEEE 802 Networking Standard, Wireless networks overview Introduction to Ad-hoc wireless networks, Cellular and Ad-hoc wireless networks, Applications of Ad-hoc wireless networks, Issues in Ad-hoc wireless networks, Ad-hoc wireless Internet

UNIT – II

MAC Protocols for Ad-hoc wireless networks: Issues in Designing a MAC protocol for Ad-hoc Wireless Networks, Design goals of a MAC protocol for Ad Hoc Wireless Networks, Classifications of MAC protocols, Contention –based protocols, Contention-based protocols with reservation Mechanisms, Contention –based MAC protocols with Scheduling Mechanisms, MAC protocols that use Directional Antennas, Other MAC protocols.

UNIT – III
*Routing protocols for Ad-hoc wireless networks***:** Issues in Designing a Routing protocol for Ad Hoc Wireless Networks, Classification of Routing protocols, Table-Driven Routing protocols, On-Demand Routing protocols, Hybrid Routing protocols, Routing protocols with Efficient Flooding Mechanisms, Hierarchical Routing protocols, Power –Aware Routing protocols.
UNIT – IV
Transportation Layer Protocols for Ad-hoc wireless networks: Introduction, Issues in Designing a Transport Layer protocol for Ad-hoc Wireless Networks, Design goals of a Transport Layer Protocol for Ad hoc Wireless Networks, Classification of Transport Layer Solutions, TCP over Ad hoc Wireless networks, Other Transport Layer protocol for Ad hoc Wireless Networks.
UNIT – V
Security Protocols for Ad-hoc wireless networks: Security in Ad-hoc wireless networks, Network security requirements, Issues and challenges in Security provisioning, Network Security attacks, Key management, Secure routing in Ad-hoc wireless networks

References:

1	C. Siva Ram Murthy and B.S. Manoj, "*Ad Hoc Wireless Networks: Architectures and protocols",* 2004, PHI
2	George Aggelou, *"Mobile Ad Hoc Networks",* Tata McGraw-Hill, 2009.
3	C.K.Toh , *"Ad hoc Mobile Wireless Networks: Protocols & Systems",* 1st Ed.Pearson Education. 2002.
4	Jagannathan and Sarangapani, *"Wireless Ad-hoc and Sensor Networks: Protocols, Performance and Control*", 1st Edition, CRC Press, 2007.
5	Ozan K. Tonguz, Gianluigi Ferrari, *"AD HOC Wireless Networks: A Communication-Theoretic Perspective*", Wiley Student Edition, 2009

PROGRAM SPECIFIC ELECTIVE - IV

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

EC 319

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To study the electromagnetic interference control techniques.*
2.	*To learn electromagnetic compatibility issues with regard to the design of PCBS and discuss electromagnetic interference measurements and standards.*
3.	*To instil knowledge on the EMI coupling mechanism and its mitigation techniques and impart comprehensive insight about the current EMC standards and about various measurement techniques.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Be able to explain the requirement of EMI & EMC concept and impart knowledge on different units and standards used for Electromagnetic compatibility in electronic/electric system.*
2.	*Have an ability to analyze and evaluate the impact of EMI mitigation techniques such as shielding and grounding etc.*
3.	*Have an ability to analyze, measure and evaluate radiated and conducted emissions to examine the compatibility.*
4.	*Find solution to EMI Sources, EMI problem in Subsystem and system level design.*
5.	*Find solution to EMI Sources, EMI problems in PCB level design*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction and History of EMI-EMC, Sources & effects of EMI – Intersystem & Intrasystem, Electromagnetic Environment Effects (E3), Common EMI measurement units. Time domain & frequency domain representation of periodic, non-periodic and digital waveforms.
UNIT – II
Conducted Emission & Susceptibility, Radiated Emission & Susceptibility, ESD, Introduction of Commercial & Military EMI Standards, Measurement of EMI, Shielded Enclosure, Antennas, Probes Equipment & Accessories used in EMI measurement.
UNIT – III
EMI Mitigation Techniques, Grounding, Shielding, Filtering & Bonding, EMI Suppression

Components like EMI Filters (DC/AC), RFI Filters, EMI Gaskets, RF absorbing material, Transient Voltage Suppressors, Honey-comb vents etc., Cables, Connectors.
UNIT – IV
Sub-system and System level EMC, EMC Design of analog and digital Sub-systems, Mixed Signal PCB layout for better EMC, Analog and Digital grounds, EMC of A/D & D/A Converters, EMC of DC-DC Converters and Power Supplies, EMC Design Guidelines , Introduction to Signal Integrity, .
UNIT – V
Introduction to Numerical EMI & EMC Simulation Techniques, Survey of Commercially available EMC Software, Introduction to Intentional EMI, EMP, Electromagnetic Weapons.

[PTO]

References:

1	Clayton R. Paul **"***Introduction to Electromagnetic Compatibility***"** Wiley Publication.
2	Dr. V.P. Kodali, "*Engineering Electromagnetic Compatibility*" IEEE Press,1996.
3	Henry W. Ott, *"Electromagnetic Compatibility Engineering"* Wiley Publication**.**

OPTICAL COMMUNICATIONS AND NETWORKS

EC 320

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To know the basic geometric structures of Optical fibres, Light laws, modes of operation and losses in fibres.*
2. *To know the physical principles of optical sources and optical detectors and develop the design models and design the analog and digital optical links, the noise effects and error control techniques.*
3. *To understand the working of various optical components, WDM concepts and knowledge about Soliton Pulses and to know the design aspects of various Optical networks and their applications*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand and analyze the design principles of Optical fibres and their losses.*
2. *Analyze the design aspects of various types of Optical sources and detectors.*
3. *Analyze and design the optical links for different applications.*
4. *Know the working of WDM systems and various optical components for different applications.*
5. *Choose the optical networks for various applications.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Optical Fibres: Overview of Optical fibre communications, Elements of an Optical fibre transmission Link, Nature of light, Basic optical laws and definitions, Modes and configurations, Single & Multi mode step index and Graded index Fibres, Fibre materials. *Signal degradation in Optical Fibres:* Attenuation, Signal Distortion in Optical Waveguides Dispersion, Pulse broadening in graded index fibres, Mode coupling, Design optimization of single mode Fibres.

UNIT – II

Optical Sources: Semiconductors physics, LEDs and Laser diodes, Linearity of sources, Modal, Partition and reflection noise.
Photodetectors: Physical principles of PIN and APD, Photo detector noise, detector response

time, Avalanche multiplication noise, Temperature effect on avalanche gain, Comparison of Photo detectors.
UNIT – III
Optical Receiver Operation: Fundamental Receiver operation, Digital receiver performance calculations, Preamplifiers types, Analog receivers. *Digital Transmission Systems:* Point to point links, Line coding, Error correction, Noise effects on system performance, Overview of Analog links, Carrier-to-noise ratio.
UNIT – IV
WDM: Concepts and components, Operational principles of WDM, Passive components, Tunable sources, Tunable filters, Introduction of optical amplifiers, Soliton Pulses.
UNIT – V
Optical Networks: Basic Networks, SONET/SDH, Broadcast and select WDM networks, Wavelength Routed Networks, Nonlinear effects on Network Performance, Performance of EDFA+WDM systems, Optical CDMA, Ultrahigh capacity Networks.

References:

1	Djafar K.mynbaev Lowell l.Scheiner, "*Fibre Optic Communications Technology",* Pearson Education Asia, 2006.
2	Senior John M. "*Optical Fibre Communications Principles and Practice",* Prentice Hall India, second edition, 1996.
3	3. Keiser Gerd, "*Optical Fibre Communications",* Mc GrawHill, Third edition, 1991.
4	Govind P.agarwal, *"Fiber-Optic Communication Systems*", Third edition, John Wiley & Sons, 2002.
5	5. Joseph C. Palais, *"Fibre Optic Communications*", Fifth edition, Pearson Education, 2004.

OPTIMIZATION TECHNIQUES

EC 221

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To introduce various optimization techniques i.e classical, linear programming, transportation problem, simplex algorithm, dynamic programming*
2. *Constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations.*
3. *To explain the concept of Dynamic programming and its applications to project implementation.*

Outcomes: *At the end of this course, students will be able to:*

1. *Explain the need of optimization of engineering systems*
2. *Understand optimization of electrical and electronics engineering problems*
3. *Apply classical optimization techniques, linear programming, simplex algorithm, transportation problem*
4. *Apply unconstrained optimization and constrained non-linear programming and dynamic programming*
5. *Formulate optimization problems.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Use of optimization methods. Introduction to classical optimization techniques, motivation to the simplex method, simplex algorithm, sensitivity analysis.
UNIT – II
Search methods - Unrestricted search, exhaustive search, Fibonocci method, Golden section method, Direct search method, Random search methods, Univariate method, simplex method, Pattern search method.
UNIT – III
Descent methods, Gradient of function, steepest decent method, conjugate gradient method. Characteristics of constrained problem, Direct methods, The complex method, cutting plane method.

UNIT – IV
Review of a global optimization techniques such as Monte Carlo method, Simulated annealing and Tunneling algorithm.
UNIT – V
Generic algorithm - Selection process, Crossover, Mutation, Schema theorem, comparison between binary and floating-point implementation.

References:

1	SS Rao, *"Optimization techniques*", PHI, 1989
2	Zhigmiew Michelewicz, *"Genetic algorithms + data structures = Evaluation programs"*, Springer Verlog - 1992.
3	Merrium C. W., *"Optimization theory and the design of feedback control systems"*, McGraw Hill, 1964.
4	Weldo D.J., *"Optimum seeking method",* PHI, 1964.

AUDIT COURSE –II
DISASTER MANAGEMENT

AC 105

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters*
2.	*To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters*
3.	*To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Learn to demonstrate a critical understanding of key concepts in disaster risk reduction*
2.	*Humanitarian response*
3.	*Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.*
4.	*Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.*
5.	*Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT – II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT – III
Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics
UNIT – IV
Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.
UNIT – V
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

References:

1	R. Nishith, Singh AK, *"Disaster Management in India: Perspectives, issues and strategies"*, New Royal Book Company.
2	Sahni, Pardeep (Eds.), *"Disaster Mitigation Experiences and Reflections"*, PHI, New Delhi.
3	Goel S. L., *"Disaster Administration and Management Text and Case Studies",* Deep & Deep Publication Pvt. Ltd., New Delhi.

PEDAGOGY STUDIES

AC 106

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*To present the basic concepts of design and policies of pedagogy studies.*
2.	*To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices and familiarize various theories of learning and their connection to teaching practice.*
3.	*To create awareness about the practices followed by DFID, other agencies and other researchers and provide understanding of critical evidence gaps that guides the professional development*

Outcomes: *At the end of this course, students will be able to:*

1.	*Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.*
2.	*Examine the effectiveness of pedagogical practices.*
3.	*Understand the concept, characteristics and types of educational research and perspectives of research.*
4.	*Describe the role of classroom practices, curriculum and barriers to learning.*
5.	*Understand Research gaps and learn the future directions.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT – II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT – III

*Evidence on the Effectiveness of Pedagogical Practices***:** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT – IV
Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.
UNIT – V
Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

References:

1	Ackers J, Hardman F, *"Classroom Interaction in Kenyan Primary Schools, Compare*", 31 (2): 245 – 261, 2001.
2	2. Agarwal M, *"Curricular Reform in Schools: The importance of evaluation*", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3	Akyeampong K, "*Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)",* Country Report 1. London: DFID, 2003.
4	Akyeampong K, Lussier K, Pryor J, Westbrook J, *"Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?"* International Journal Educational Development, 33 (3): 272- 282, 2013.
5	Alexander R J, *"Culture and Pedagogy: International Comparisons in Primary Education",* Oxford and Boston: Blackwell, 2001.
6	Chavan M, Read India: *"A mass scale, rapid, learning to read campaign",* 2003

STRESS MANAGEMENT BY YOGA

AC 107

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Creating awareness about different types of stress and the role of yoga in the management of stress.*
2. *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
3. *Prevention of stress related health problems by yoga practice.*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through asanas.*
5. *Improve work performance and efficiency.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.
UNIT – II
Meaning and Definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.
UNIT – III
Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress
UNIT – IV
Asanas - (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.
UNIT – V
Pranayama - Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama. *Meditation Techniques:* Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

References:

1	Janardhan Swami Yogabhyasi Mandal, "*Yogic Asanas for Group Training - Part-I*", , Nagpur.
2	Advaita Ashrama, "*Swami Vivekananda, "Rajayoga or Conquering the Internal Nature",* (Publication Department), Kolkata.
3	Nagendra H.R and Nagaratna R, "*Yoga Perspective in Stress Management",* Swami Vivekananda Yoga Prakashan, Bangalore.

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

AC 108

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Outcomes: *At the end of this course, students will be able to:*

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)
UNIT – II
Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.
UNIT – III
Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48
UNIT – IV
Statements of Basic Knowledge - Shrimad Bhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.
UNIT – V
Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

[PTO]

References:

1	"*Srimad Bhagavad Gita",* Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2	P.Gopinath, *"Bhartrihari's Three Satakam (Niti-sringar-vairagya*)", Rashtriya Sanskrit Sansthanam, New Delhi

MICROWAVE SYSTEMS LABORATORY-II

EC 352

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1. To get acquaint with RF test and measurement equipment
2. To get acquaint with EM Simulation Software
3. To become familiar with the Design and simulation of passive RF subsystems

Outcomes: *At the end of this course, students will be able to:*

1. Able to acquire the Knowledge on RF Test and measurement instruments
2. Able to acquire the knowledge to use RF CAD software
3. Able to Design RF subsystems
4. Able to design MEMS switches and phase shifters
5. *Able to Test, analyze and validate the performance of RF components and systems*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Experiments

1. Calibration with Vector Network Analyzer
2. Study of Spectrum Analyzer
3. Study of non-ideal behavior of lumped circuit components using Network Analyzer
4. Characterization of Micro strip Filters, Couplers and Resonators using Spectrum Analyzer and Network Analyzer.
5. Software simulation and design of passive Microwave Components and printed antennas using
   Ansys HFSS
   Agilent Advanced Design System (ADS)
   AWR Microwave office
   SONNET High Frequency EM simulator
   Zeland IE3D
6. Software simulation of MEMS switches, phase shifters using COMSOL Multi physics.

SEMINAR – II

EC 362

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Outcomes: At the end of this course, students will be able to**:**

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

MINI PROJECT WITH SEMINAR

EC 371

Instruction: 6 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 3

Outcomes: *At the end of this course, students will be able to:*

1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained
5. Write the documentation in standard format

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter-disciplinary/ industry relevance.
- The students can select a mathematical modeling based/Experimental investigations or Numerical modeling
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

SEMESTER - III

PROGRAM SPECIFIC ELECTIVE – V

RADAR SIGNAL PROCESSING

EC 321

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To review the Radar fundamentals,*
2. *To know the sampling criteria of Pulsed radar signals and learn various radars like MTI, Doppler and tracking radars and their comparison*
3. *To analysis the radar signals using ambiguity function and understand various technologies involved in the design of radar transmitters and receivers.*

Outcomes: *At the end of this course, students will be able to:*

1. *Know how a radar is built and understand the principles of behavior*
2. *Understand the basic principles of signal processing done in a radar.*
3. *Be able to estimate the performance of a radar based on parameters provided.*
4. *Be able to assess what type of radar is suitable for which task (choice of waveforms, frequency bands, etc.*
5. *Be able to use numerical tools to calculate radar performance and to simulate the signal processing in a radar.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
A Preview of Basic Radar Signal Processing, Radar Literature, Signal Models, components of a Radar Signal, Amplitude Models, clutter, Noise Model and Signal -to -Noise Ratio, Jamming, Frequency Models-The Doppler Shift, Spatial Models, Spectral Model.
UNIT – II
Sampling and Quantization of Pulsed Radar Signals, Domains and Criteria for Sampling Radar Signals, Sampling in the Fast Time Dimension, Sampling in Slow Time – Selecting the Pulse Repetition Interval, Sampling the Doppler Spectrum, Sampling in the Spatial and Angle Dimensions, Quantization, I/Q Imbalance and Digital I/Q
UNIT – III

Radar waveforms: The waveform Matched filter, Matched filter for Moving Targets, Radar Ambiguity Function and Ambiguity Diagram-Principles and Properties; Specific Cases – Ideal Case, Single Pulse of Sine Wave, Periodic Pulse Train, Single Linear FM Pulse.
UNIT – IV
Doppler Processing, Alternate Forms of the Doppler Spectrum, Moving Target Indication (MTI), Pulse Doppler Processing, Pulse Pair Processing, Additional Doppler Processing Issues, Clutter Mapping and the Moving Target Detector, MTI for moving platforms.
UNIT – V
Pulse Compression in Radar Signals: Introduction, Significance, Types, Frequency Modulated Pulse compression wave forms, Range side lobe control for FM waveforms, Phase modulated pulse compression wave forms, Costas Frequency codes.

References:

1	Mark A. Richards, *"Fundamentals of Radar Signal Processing*", McGraw Hill
2	M.I. Skolnik, "*Introduction to Radar Systems*", 3rd Edition, 2001, TMH.
3	R. Nitzberg, "*Radar Signal Processing and Adaptive Systems*", 1999, Artech House.
4	F.E. Nathanson, "*Radar Design Principles*", 1st Edition, 1969, McGraw Hill.

MICROWAVE SOLID STATE DEVICES AND APPLICATIONS

EC 322

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To understand operating characteristics of Microwave BJTs, GaAs FETs, low noise and power GaAs FETs and their applications.*
2. *To understand FET working principle and its applications as attenuators and phase shifters.*
3. *To learn the Microwave Mixers design using diodes and FETs and microwave Oscillators design using IMPATT diodes and FETs.*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand the working principles of the Microwave solid state devices (Microwave BJTs. GaAs FETs, low noise and power GaAs FETs, IMPATT Diodes)*
2. *Choose a suitable microwave solid state device for a particular application.*
3. *Understand the use of microwave semiconductor devices in RF Switches, Phase shifter and attenuators.*
4. *Understand the use of microwave semiconductor devices in microwave amplifiers and oscillators.*
5. *Understand the use of microwave semiconductor devices in design of microwave, mixers.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to two terminal microwave devices. Microwave BJTs. GaAs FETs, low noise and power GaAs FETs and their applications. DC biasing, Z and Y smith charts and impedance matching circuits.
UNIT – II
RF Switches, Phase shifter and attenuators: SPST and SPDT design using FETs, FET based attenuators and phase shifters. Characterization of Switches, attenuators and phase shifters
UNIT – III
Amplifiers - Microwave transistor 'S' parameters. Power gain equations, stability, impedance matching, constant gain and noise figure circles; Small signal, low noise, high-power and broadband amplifier designs. Characterization of amplifiers.

UNIT – IV
Oscillators: Negative resistance concept, types of resonators, oscillator condition. One port, two port, YIG dielectric oscillators, broad band oscillator, Gunn diode oscillator design, and wave guide cavity IMPATT oscillator design. FET oscillator design. Characterization of oscillators.
UNIT – V
Microwave Mixers design: Diode mixer theory, single diode mixers; single balanced, double balanced mixers.FET mixer theory, balanced FET mixers, and special mixer circuits. Characterization of Mixers.

References:

1	S.Y. Liao, "*Microwave Circuit Analysis and Amplifier Design",* Prentice Hall, 1987.
2	G.D. Vendelin, A.M. Pavio, U.L. Rohde, *"Microwave Circuit Design, Using Linear and Non-linear Techniques*", John Wiley, 1990.
3	S.Y.Liao, *"Microwave Devices and Circuits",* Third addition, , Prentice Hall.
4	Guillermo and Gonzalez, *"Microwave Transistor Amplifiers: Analysis and Design"*, (2nd Edition), 1996
5	Stephen A. Maas, *"Microwave Mixers",* (Artech House Antennas and Propagation Library) (Artech House Microwave Library) 1993
6	Inder J. Bahl, "*Control Components Using Si, GaAs, and GaN Technologies*"

SOFTWARE DEFINED RADIO

EC 323

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To provide fundamental concepts in SDR.*
2. *To explore the reconfigurable features of modern radio communication systems.*
3. *To demonstrate SDR on any DSPs and FPGAs.*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand the basic architecture and design principles of SDR.*
2. *Analyze the parameters of analog RF components as front end block in implementation of SDR.*
3. *Understand the concepts of digital converter and frequency converter fundamentals.*
4. *Understand the digital hardware architectures and development methods.*
5. *Implement SDR on available hardware devices like DSPs and FPGAs.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to Software Defined Radio: A Traditional Hardware Radio Architecture, Signal Processing Hardware History, Software Defined Radio Project Complexity. A Basic Software Defined Radio Architecture: 2G Radio Architectures, Hybrid Radio Architecture, Basic Software Defined Radio Block Diagram, System Level Functioning Partitioning,Digital Frequency Conversion Partitioning.
UNIT – II
RF System Design: Introduction- Noise and Channel Capacity, Link Budget, Receiver Requirements, Multicarrier Power Amplifiers, Signal Processing Capacity Tradeoff.
UNIT – III
Analog-to-Digital and Digital-to-Analog Conversion: Digital Conversion Fundamentals, Sample Rate, Bandpass Sampling, Oversampling- Antialias Filtering, Quantization, ADC Techniques-Successive Approximation, Figure of Merit-DACs, DAC Noise Budget, ADC Noise Budget.
UNIT – IV
Digital Frequency Up- and Down Converters: Introduction- Frequency Converter Fundamentals, Digital NCO, Digital Mixers, Digital Filters, Halfband Filters, CIC Filters,Decimation, Interpolation, and Multirate Processing,DUCs, Cascading Digital

Converters and Digital Frequency Converters.
UNIT – V
Hardware and Software Components: SDR Requirements for Processing Power- DSPs- DSP Devices- DSP CompilersReconfigurable Processors-Adaptive Computing Machine- FPGAs, Major Software Architecture Choices, Hardware – Specific Software Architecture, Software Standards for Software Radio, Software Design Patterns, Component Choices, Real Time Operating Systems, High Level Software Languages, Hardware Languages.

References:

1	Paul Burns, "*Software Defined Radio for 3G",* Artech House, 2002
2	Tony J Rouphael, "*RF and DSP for SDR",* Elsevier Newnes Press, 2008
3	Jouko Vanakka, *"Digital Synthesizers and Transmitter for Software Radio*", Springer, 2005

MICROWAVE INTEGRATED CIRCUITS

OE 903

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To get familiar with MIC Technology*
2. *To know the most commonly used planar transmission lines for MIC's and to become familiar with microwave passive circuit analysis and design*
3. *To understand the microwave propagation in ferrites and use them in various applications*

Outcomes: *At the end of this course, students will be able to:*

1. Able to know about MIC Technology
2. Able to know most commonly used Planar Transmission lines
3. Able to understand the operation and design of passive microwave devices such as power dividers, couplers and filters
4. Able to understand the microwave propagation in ferrites and use them in various applications
5.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction, Types of MICs, Technology of Hybrid MICS: Dielectric substrates, thick film technology and materials, thin film technology and materials, methods of testing, encapsulation and mounting of active devices. *Technology of Monolithic MICS*: Processes involved in fabrication, epitaxial growth of semiconductor layer, growth of dielectric layer, diffusion-ion implantation, electron beam technology.
UNIT – II
Analysis of microstrip line and strip line. Method of conformal Transformation. Characteristic parameters of Microstrip, strip lines. Introduction to slot line and coplanar waveguide.
UNIT – III
Introduction to Coupled Microstrips, Even and odd mode analysis. Theory of coupled microstrip Directional couplers. Calculations for a coupled pair of Microstrips. Branch line couplers.

UNIT – IV
Lumped Elements for MIC's Design and fabrication of lumped elements, circuits using lumped elements-Impedance transformers, Filters.
UNIT – V
Nonreciprocal components for MIC's, Microstrip on Ferrimagnetic substrates, Microstrip circulators. Isolators and phase shifters. Applications of MIC's.

References:

1	Gupta KC, and Amarjit Singh, "*Microwave Integrated circuits",* Wiley Eastern,1974.
2	Hoffman R.K. *"Hand Book of Microwave integrated Circuits",* Artech House,Boston, 1987.
3	B. Bhat and S.K. Koul, *"Strip line like transmission lines for microwave integrated circuits*", New age publishers, 2007 Edition.
4	D.M. Pozar, *"Microwave Engineering",* John Wieley, USA, Paperback edition.

MAJOR PROJECT PHASE - I

EC 381

Instruction: 20 periods per week *Duration of SEE: --*
CIE: 100 marks *SEE: --*
Credits: 10

Outcomes: *At the end of this course, students will be able to:*

1.	*Exposed to self-learning various topics.*
2.	*Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.*
3.	*Learn to write technical reports.*
4.	*Develop oral and written communication skills to present.*
5.	*Defend their work in front of technically qualified audience*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, Osmania University and Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

SEMESTER - IV

MAJOR PROJECT PHASE - II

EC 382

Instruction: 32 periods per week *Duration of SEE: --*
CIE: -- *SEE: 200 marks*
Credits: 16

Outcomes: *At the end of this course, students will be able to:*

1. *Use different experimental techniques and will be able to use different software/ computational /analytical tools.*
2. *Design and develop an experimental set up/ equipment/test rig.*
3. *Conduct tests on existing set ups/equipment and draw logical conclusions from the results after analysing them.*
4. *Either work in a research environment or in an industrial environment.*
5. *Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester - III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head, Osmania University and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS & Head, Osmania University (All together	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce

EMBEDDED SYSTEMS AND VLSI DESIGN

SEMESTER - 1

ANALOG AND DIGITAL CMOS VLSI DESIGN

EC 401

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Analyze, design, optimize and simulate analog and digital circuits using CMOS constrained by the design metrics.*
2. *Connect the individual gates to form the building blocks of a system and using EDA tools like Cadence, Mentor Graphics and other open source software tools like Spice.*
3. *Understand the advanced technologies and Passive and active current mirrors*

Outcomes: *At the end of this course, students will be able to:*

1. *Design MOS transistor circuits*
2. *Know the Physical design flow and different modelling design*
3. *Design sequential circuits at higher level*
4. *Design analog circuits like single stage and differential amplifiers*
5. *Analyze frequency response of active circuits*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Review: Basic MOS structure and its static behavior, Quality metrics of a digital design: Cost, Functionality, Robustness, Power, Delay, Wire delay models. Physical design flow: Floor planning, Placement, Routing, CTS, Power analysis and IR drop estimation-static and dynamic, ESD protection-human body model.
UNIT – II
Inverter: Static CMOS inverter, Switching threshold and noise margin concepts and their evaluation, Dynamic behavior, Power consumption. Combinational logic: Static CMOS design, Logic effort, Ratioed logic, Pass transistor logic, Dynamic logic, Speed and power dissipation in dynamic logic, Cascading dynamic gates, transmission gate logic.
UNIT – III
Sequential logic: Static latches and registers, Bi-stability principle, MUX based latches, Static SR flip-flops, Master-slave edge-triggered register, Dynamic latches and registers, Concept of pipelining, Pulse registers, Non-bistable sequential circuit.

Advanced technologies: Giga-scale dilemma, Short channel effects, High–k, Metal Gate Technology, FinFET, TFET.
UNIT – IV
Single Stage Amplifier: CS stage with resistance load, Diode connected load, Current source load, Triode load, CS stage with source degeneration, Source follower, Common gate stage, Cascode stage, Choice of device models. *Differential Amplifiers:* Basic differential pair, Common mode response, Differential pair with MOS loads, Gilbert cell.
UNIT – V
Passive and active current mirrors: Basic current mirrors, Cascode mirrors, Active current mirrors.

References:

1	J P Rabaey, A P Chandrakasan, B Nikolic, *"Digital Integrated circuits: A design perspective"*, Prentice Hall electronics and VLSI series, 2nd Edition.
2	Baker, Li, Boyce, "*CMOS Circuit Design, Layout, and Simulation*", Wiley, 2nd Edition.
3	BehzadRazavi , "*Design of Analog CMOS Integrated Circuits",* TMH, 2007
4	Phillip E. Allen and Douglas R. Holberg, "*CMOS Analog Circuit Design"*, Oxford, 3rd Edition.
5	Kang, S. and Leblebici, Y., *"CMOS Digital Integrated Circuits, Analysis and Design*", TMH, 3rdEdition.
6	Pucknell, D.A. and Eshraghian, K., "*Basic VLSI Design*", PHI, 3rd Edition.

MICROCONTROLLERS AND PROGRAMMABLE DIGITAL SIGNAL PROCESSORS

EC 402

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To understand the instructions and program the 8051*
2.	*To gain the knowledge of ARM cortex on Zynq for Embedded systems and on LPC 214xx microcontroller.*
3.	*To understand basic features of programmable DSP processor and to study instruction set and addressing modes of TMS 320C 54XX.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Understand the architecture of a microcontroller to design applications using them.*
2.	*Compare and select ARM processor core based SoC with several features/peripherals based on requirements of embedded applications.*
3.	*Develop simple applications using LPC 214xx microcontroller.*
4.	*Identify and characterize architecture of Programmable DSP Processors.*
5.	*Develop small applications by utilizing the ARM processor core and DSP processor-based platform.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Microcontroller architecture: Review of 8051 architecture: 8051 registers, Memory organizations-program memory and data memory, internal RAM and bit addressable memory, special functions register. Interfacing 8051 with peripherals – LCD, Stepper motor, ADC, DAC, PWM, Relay.

UNIT – II

ARM Embedded Systems: The RISC design philosophy, The ARM design philosophy, ARM processor fundamentals, LPC 214x microcontroller Features, architecture, Internal memory, system control, pin connect block, GPIOs, Timers, ADC, UART, CAN, I2C, Pulse Width Modulation, RTC, WDT.

UNIT – III

LPC 214x microcontroller Interfacing with real world: Basic Instructions and Assembly language programming- Arithmetic, Logical, and branching instructions, C-language programming for Interfacing with LCD display, Keypad and DC motors, serial programming.

UNIT – IV
Programmable DSP Processors: Basic Architectural features, DSP Computational Building blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation unit, Programmability and Program execution, Speed Issues.
UNIT – V
Commercial Digital Signal-Processing Devices: Data addressing modes of TMS320C54xx Digital signal processors, Data Addressing modes of TMS320C54xx processors, Memory space of TMS32054xx processors, Program control, TMS320C54xx instructions and programming, On-chip peripherals, Interrupts of TMS320C54xx processors, pipeline operation of TMS320C54xx processors.

References:

1	Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D.McKinlay, "*The 8051 Microcontroller and Embedded Systems using Assembly and C*", 2nd Edition, Pearson education, 2009.
2	Sloss Andrew N, Symes Dominic, Wright Chris, "*ARM System Developer's Guide: Designing and Optimizing"*, Morgan Kaufman Publication
3	User Manual of LPC214X Microcontroller
4	Avatar Singh and Srinivasan. S, *"Digital Signal Processing Implementations",* Thomson Books, Singapore, 2004.
5	Venkatramani B. and Bhaskar M *"Digital Signal Processors: Architecture, Programming and Applications"* , TMH , 2nd Edition

PROGRAM SPECIFIC ELECTIVE - I

ADVANCED COMPUTER ARCHITECTURE

EC 111

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To Design Basic Data Path Unit (DPU) and Control Unit (CU) and to Familiarize with Parallel Processing Architectures*
2. *To Develop OpenCL Programming Environment and developing Kernel Programming*
3. *To Know Heterogeneous Architectures*

Outcomes: *At the end of this course, students will be able to:*

1. *To Realize Data Path Unit (DPU) and Control Unit (CU)*
2. *To Analyze the Performance of Multi-Core Architectures*
3. *To Demonstrate OpenCL Programs for real time applications*
4. *To Implement Kernels for Heterogeneous Architectures in OpenCL*
5. *To List and Describe the Challenges in Advanced Parallel Processing Architectures*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Processor Design:

CPU Design – CPU Organization – Data Path Design: Fixed Point Booth's Multiplier, Restoring Division Unit and Non-Restoring Division Unit.

Memory Hierarchy **–** Virtual Memory – Cache Memory

Control Unit Design – Hardwired Control Unit Design of Basic CPU.

Case Studies: Verilog HDL Implementation of Booth's Multiplication, Restoring and Non-Restoring Division and Hardwired Control Unit Realization of Basic CPU

UNIT – II

Multi Core Architectures:

RISC, CISC, Flynn's Classification, Instruction Level Parallelism: Super Scalar, VLIW and EPIC architectures. Scalable, Multithreaded and Dataflow Architectures: Principles of Multithreading, Fine-Grain Multithreading, Scalable and Multithreaded Architectures and Dataflow and Hybrid Architectures.

Case Studies: Threads and OpenMP

UNIT – III
Accelerated Architectures: GPU: nVidia and AMD Architecture – GPU memory and Scheduling, Parallel Programming Development and Environment: MPI – CUDA – OpenCL: Introduction, Platform and Devices, Execution Environment and Memory Model *Case Studies:* OpenCL programming
UNIT – IV
Low Power Architectures: System on Chip Architectures – Raspberry-Pi, nVidia SoC – Basics of Kernels: Kernels, Work-items, Work-groups and Execution Domain, OpenCL Synchronization *Case Studies:* Programming on Raspberry Pi.
UNIT – V
Advances in Parallel Processor Architectures: *Hybrid Architectures* – Issues and Challenges in Heterogeneous Computing, Schedulers, Process Synchronization and Programming *Virtualization* – Processor and Memory *Case Studies:* Hybrid Programming using CPU and GPU

References:

1	Hayes John P, "*Computer Architecture and organization,"* 3rd edition, McGraw Hill Education, 1998.
2	William Stallings, *"Computer Organization and Architecture: Designing for Performance",* 8th edition, PHI, 2007.
3	Hwang and Naresh Jotwani, *"Advanced Computer Architecture: Parallelism, Scalability and Programmability,*" McGraw Hill Education, 2017.
4	Benedict Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry and Dana Schaa, *"Heterogeneous Computing with OpenCL,"* Morgan Kaufmann Publications, 2011.

CPLD AND FPGA ARCHITECTURE

EC 411

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *Understand the basic operation of Programmable gate arrays*
2. *Learn the architecture of various types of FPGAs/CPLD and design a digital circuit and implement it on an FPGA,*
3. *Implemented the programming techniques used in FPGA design and Verification, testing FPGAs.*

Outcomes: *At the end of this course, students will be able to:*

1. *At the end of the course, students will demonstrate the ability to:*
2. *Familiarity architecture of various types of FPGAs/CPLD.*
3. *Design a digital circuit and implement it using reconfigurable logic.*
4. *Design and develop IP cores and Prototypes in FPGA design.*
5. *Apply simulators and verify develop FPGA designs.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Programmable Logic Devices: Revision of basic Digital systems, PROM, PLA, PAL, Architecture of PAL's applications, programming technologies, programmable logic design methods and tools.
UNIT – II
CPLD's: complex programmable logic devices: logic block, I/O block, interconnect matrix, logic blocks and features of altera flex logic 10000 series CPLD‟s , max 7000 series CPLD‟s, AT & T– ORCA‟s (Optimized Reconfigurable Cell Array), cypres flash 370 device technology, lattice plsi‟s architectures.
UNIT – III
FPGAs: Field Programmable Gate Arrays: Logic blocks, routing architecture, Logic cells and features of commercially available FPGA‟s- XILINX XC4000, SPARTAN II, virtexII FPGA‟s, XILINX, Altera's FPGA, ACETEL Act1, Act2, Act3 FPGAS , AMD FPGA.
UNIT – IV
Placement: objectives, placement algorithms: Mincut-Based placement, iterative improvement Placement, simulated annealing. *Routing:* objectives, segmented channel routing, Maze routing, Routability estimation, Net delays, Computing signal delay in RC tree networks.

UNIT – V
FPGA implementation steps: Synthesis and simulation process, verification: introduction, logic simulation, design validation, timing verification. Testing concepts: failures, mechanisms and faults, fault coverage, ATPG methods, programmability failures, Case studies: programmable counter, ALU, Barrel shifter.

References:

1	P.K. Chan & S. Mourad, *"Digital Design Using Field Programmable Gate Array",* Pearson Education 2009.
2	S. Trimberger, Edr., *"Field Programmable Gate Array Technology",* Kluwer Academic Publications, 1994.
3	J. Old Field, R. Dorf, *"Field Programmable Gate Arrays*", John Wiley & Sons, Newyork, 1995.
4	S. Brown, R. Francis, J. Rose, Z.Vransic, *"Field Programmable Gate array*", Kluwer Publn, 1992
5	*Manuals* from Xilinx, Altera, AMD, Actel.

PROGRAM SPECIFIC ELECTIVE - II

SATELLITE NAVIGATION SYSTEM

EC 412

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand about the Satellite Subsystems, launch vehicles and Earth station
2. To study about different types of receivers, coordinate systems and GNSS errors
3. To analyze the significance of other GNSS constellations, SBAS and their applications.

Outcomes: *At the end of this course, students will be able to:*

1. Understand the various principles related to Satellite communication systems.
2. Study the operation of GNSS, its signal structure and receiver types.
3. Estimate the various GNSS errors and understand the RINEX data format.
4. Compare the various features of other GNSS constellations, SBAS and GBAS
5. Analyze the applications of Satellite Navigation Systems.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Review of Satellite communications: Origin of Satellite Communication**,** basic principles and properties of Satellite communication, Spacecraft subsystems, Earth Stations: Functional block diagram and its operation, Merits and limitations of Large, Medium and Small Earth stations, Satellite launches: SLV, ASLV, PSLV and GSLV, Orbital effects on Satellite communication system performance.

UNIT – II

Basics of GNSS: Trilateration, Introduction and Heritage of NAVSTAR GPS, GPS Principle of operation, architecture, operating frequencies, advantages and limitations of GPS, orbits, GPS and UTC Time, GPS Signal structure, C/A and P-Code, ECEF and ECI coordinate systems and WGS 84, Operation of Generic GPS receiver functional block diagram, Types of GPS Receivers: Dual, Single frequency code, carrier smoothed, code & carrier receivers.

UNIT – III

GNSS Errors: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Multipath, Dilution of Precision, Spoofing and Anti-spoofing, GPS Modernization program, Objectives and important features, RINEX Navigation and Observation data formats.

UNIT – IV
GNSS and Augmentation systems: GLONASS, GALILEO, COMPASS, QZSS, IRNSS-Architecture, their operation, current status, Comparisons of all GNSS, Need for Satellite Based Augmentation and Local Area Augmentation Systems (SBAS and GBAS) and its operation, Advantages and limitations of SBAS and GBAS.
UNIT – V
GNSS Navigation Applications: Applications of GNSS to Land Vehicle Navigation and Tracking, Marine applications, Air Traffic Control, Surveying, Mapping and Geographical Information Systems, Military and Space, Recreation and Sports, Timing and Synchronization, Public related and Indoor navigation.

References:

1	B.HofmannWollenhof, H.Lichtenegger, and J.Collins, "*GPS Theory and Practice"*, Springer Wien, York, 2000.
2	Pratap Misra and Per Enge, *"Global Positioning System Signals, Measurements, and Performance,"* Ganga-Jamuna Press, Massachusetts, 2001.
3	Ahmed El-Rabbany, *"Introduction to GPS,"* Artech House, Boston, 2002.
4	Bradford W. Parkinson and James J. Spilker, "*Global Positioning System: Theory and Applications,"* Volume II, American Institute of Aeronautics and Astronautics, Inc., Washington, 1996.
5	Elliot D. Kaplan, *"Understanding GPS Principles and Applications"*, Artech House Boston,1996.

SYSTEM ON CHIP DESIGN

EC 413

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To Understand the System Architecture and Processor Architecture, approach for a SOC Design and the concept of pipelining.*
2. *To Learn about SOC external memory, Scratchpads and Cache memory and Multilevel Caches.*
3. *To familiarize with on-chip memory concepts for SoC and to adopt the architectural support for operating systems.*

Outcomes: *At the end of this course, students will be able to:*

1. *Analyze the system and processor architecture approach for SoC design*
2. *Explore the concept of pipelining.*
3. *Understand the concept of memory interface and bus architecture for SoC design.*
4. *Analyze the performance metrics of on-chip memory.*
5. *Understand the architectural support for operating systems.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction to System on Chip: System Architecture components of the system, hardware and Software, processor architecture, memory and addressing, system level interconnection, an Approach for SOC design, system architecture and complexity.
Processor design: Processor architecture and organization, processor design trade-offs, the Reduced instruction set computer, the acron risc machine, architectural inheritance, the arm Programmers model, arm development tools.

UNIT – II

Organization of an SoC: 3-stage pipeline arm organization, 5-stage pipeline arm organization, the arm coprocessor interface coprocessor instructions, data operations, data transfers, the thumb bit in the cpsr, the thumb programmer's model

UNIT – III

Architectural support for system development: The arm memory interface, the advanced micro controller bus architecture (amba), the arm reference peripheral specification, hardware system prototyping tools, the armulator, the jtag boundary scan test architecture embedded trace, signal processing support.

UNIT – IV
Memory hierarchy: Memory size and speed: memory cost, on chip memory, caches: processor & memory speeds, unified & Harvard caches, cache performance metrics, the direct mapped Cache the set-associative cache, the fully associative cache, write strategies cache design-an example.
UNIT – V
Architectural support for operating systems: An introduction to operating system, the arm System control coprocessor, cp15 protection unit register, arm protection unit, cp15 mmu Registers, arm mmu architecture, synchronization, context switching, input/ouput.

References:

1	Steve furber, *"arm system-on-chip architecture"*, second edition, pearson publications
2	Andrew n.sloss, domnic symes,chris wright, *"arm system developers guide"*, publications Elsevier.

RESEARCH METHODOLOGIES IN ECE

EC 100

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To know the motivation on research philosophy and processes in general.
2. To be able to formulate the problem statement and prepare research plan for the problem under investigation through literature.
3. To be able to apply various techniques for data analysis and patenting

Outcomes:

1. Students able to understand research methodology and problems
2. Able to define the techniques involved in defining problem
3. Able to Developing a Research plan and research set up
4. Able to analyze the collection of data and statistical analysis
5. Able to have knowledge on writing the report and patenting

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Objectives and Types of research: Objectives and Motivation of research- types of research-Research approaches – Significance of Research-Research Methods versus Methodology-Research and Scientific method- Importance of research methodology – Research process-criteria of good research- Problems encountered by Researchers in India-benefits to society in general.
UNIT – II
Research formulation: Defining and formulating the research problem, selecting the problem, importance of literature review in define a problem, literature review, primary and secondary sources, reviews, monograms, patents, research data bases web as a source, identifying gap areas from literature review and research data bases, devilment of working hypothesis
UNIT – III
Research Design and methods: Meaning of research design - need of research design- features of a good design- important concepts relating to research design- different research designs-Basic Principles of experimental designs- Developing a Research plan-Exploration, descriptions diagnosis and experiment

UNIT – IV
Execution of the research and data collection: Aspect of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis, strategies and tool, data analysis with statistical packages (sigma STAT, SPSS for student test t-test, ANOVA, etc.) hypothesis testing, generalization and interpretation.
UNIT – V
Reporting and thesis writing: Structure and components of scientific reports, types of report, technical report and thesis. Thesis writing-different steps and software tools (word processing) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, illustrations and tables, bibliography, referencing and footnotes. Use of visual aids. *Patenting:* The Basics of the Patent System, Patent Law, How to Read a Patent, Protecting Invention and Planning Patent Filing, Preparing Patent Application

References:

1	C.R.Kothari, "*Research methodology, Methods & technique*", New age international publishers, 2004.
2	R.Ganesan, "*Research Methodology for Engineers*", MJP Publishers: Chennai, 2011.
3	P.Ramdass and A.Wilson Aruni, *"Research and Writing across the disciplines",* MJP Publishers, Chennai 2009
4	Matthew Y Ma, "Fundamentals of Patenting and Licensing for Scientists and Engineers" 2nd Edition 2015

AUDIT COURSE-I
ENGLISH FOR RESEARCH PAPER WRITING

AC 101

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1.	*Understand that how to improve your writing skills and level of readability*
2.	*Understand the nuances of language and vocabulary in writing a Research Paper.*
3.	*Develop the content, structure, format of writing a research paper and produce original research papers without plagiarism*

Outcomes: *At the end of this course, students will be able to:*

1.	*Interpret the nuances of research paper writing.*
2.	*Differentiate the research paper format and citation of sources.*
3.	*To review the research papers and articles in a scientific manner.*
4.	*Avoid plagiarism and be able to develop their writing skills in presenting the research work.*
5.	*Create a research paper and acquire the knowledge of how and where to publish their original research papers*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.
UNIT – II
Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.
UNIT – III
Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.
UNIT – IV
Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing - The final draft and proof reading.
UNIT – V
Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications –

Advantages/Benefits *Presentation Skills:* Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

References:

1	C. R Kothari, Gaurav, Garg, "*Research Methodology Methods and Techniques*", 4/e, New Age International Publishers.
2	Day R, "*How to Write and Publish a Scientific Paper"***,** Cambridge University Press, 2006
3	"*MLA Hand book for writers of Research Papers*", 7/e, East West Press Pvt. Ltd, New Delhi
4	Lauri Rozakis, Schaum's, "*Quick Guide to Writing Great Research Papers"*, Tata McGraw Hills Pvt. Ltd, New Delhi.

SANSKRIT FOR TECHNICAL KNOWLEDGE

AC 102

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
3. To explore the huge knowledge from ancient Indian literature

Outcomes: *At the end of this course, students will be able to:*

1. Develop passion towards Sanskrit language
2. Decipher the latent engineering principles from Sanskrit literature
3. Correlates the technological concepts with the ancient Sanskrit history.
4. Develop knowledge for the technological progress
5. Explore the avenue for research in engineering with aid of Sanskrit

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)
UNIT – II
Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series). The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).
UNIT – III
Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering): Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower- Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)
UNIT – IV
Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vedic

command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.
UNIT – V
Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthi yanthram

References:

1	M Krishnamachariar, "*History of Classical Sanskrit Literature",* TTD Press, 1937.
2	M.R. Kale, "*A Higher Sanskrit Grammar: For the Use of School and College Students*", Motilal Banarsidass Publishers, 2015.
3	Kapail Kapoor, "*Language, Linguistics and Literature: The Indian Perspective",* ISBN-10: 8171880649, 1994.
4	"*Pride of India*", Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5	Shri Rama Verma, "*Vedas the source of ultimate science",* Nag publishers, 2005.

VALUE EDUCATION

AC 103

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Understand the need and importance of Values for self-development and for National development.*
2. *Imbibe good human values and Morals*
3. *Cultivate individual and National character.*

Outcomes: *At the end of this course, students will be able to:*

1. *Gain necessary Knowledge for self-development*
2. *Learn the importance of Human values and their application in day to day professional life.*
3. *Appreciate the need and importance of interpersonal skills for successful career and social life*
4. *Emphasize the role of personal and social responsibility of an individual for all-round growth.*
5. *Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.
UNIT – II
Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.
UNIT – III
Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.
UNIT – IV
Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy

books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.
UNIT – V
Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

References:

1	Chakroborty, S.K., *"Values & Ethics for organizations Theory and practice*", Oxford University Press, New Delhi, 1998.
2	2. Jaya Dayal Goyandaka, "*Srimad Bhagavad Gita with Sanskrit Text*", Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur, 2017.

CONSTITUTION OF INDIA

AC 104

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective*
2. *To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role*
3. *Entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*

Outcomes: *At the end of this course, students will be able to:*

1. *Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.*
2. *Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.*
3. *Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru*
4. *The eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.*
5. *Discuss the passage of the Hindu Code Bill of 1956.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.
UNIT – II
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
UNIT – III
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT – IV
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
UNIT – V
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

1	*"The Constitution of India",* 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, *"Dr. B. R. Ambedkar framing of Indian Constitution",* 1st Edition, 2015.
3	M. P. Jain, "*Indian Constitution Law",* 7th Edn., Lexis Nexis, 2014.
4	D.D. Basu, *"Introduction to the Constitution of India",* Lexis Nexis, 2015.

PROGRAMMABLE CONTROLLERS AND CMOS VLSI DESIGN LABORATORY

EC 451

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1.	*To create, develop, apply, and disseminate knowledge within the microcontroller-based application development environment.*
2.	*To understand interfacing of basic peripherals with microcontrollers & ARM processors and to Know Basics of System Verilog and test coverage in System Verilog.*
3.	*To Familiarize with Object Oriented Programming and System Verilog and Explore Randomization and Threads in System Verilog.*

Outcomes:

1.	*To write an assembly language programming to perform different arithmetic, logic, looping and branching operations on ARM processors.*
2.	*To interface different programmable devices to 8051 & ARM Microcontrollers and control them by writing assembly language/embedded C programming.*
3.	*To Realize and Verify Combinational and Sequential Circuits in Verilog HDL*
4.	*To Create Object Oriented Programming Environment.*
5.	*To Propose Efficient Testable Digital Systems in System Verilog.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Cycle I

Part A: Interfacing Programs Using KEIL µvision Software on 8051 µc Development Board.

1. Assembly Language Program to Interface 7 – Segment Display to 8051 Microcontroller.
2. Assembly Language Program to display message in a 2 line x 16 characters LCD display.
3. Assembly Language program for interfacing Keypad to 8051 Microcontroller.
4. Assembly Language program for interfacing DAC to generate different waveforms.
5. Assembly Language program for interfacing stepper motor and to control it.

Part B: Implement the following Programs on ARM Processor.

1. Simple Assembly Program for
    a. Addition | Subtraction | Multiplication | Division
    b. Operating Modes, System Calls and Interrupts
    c. Loops, Branches
2. Assembly programs to configure and control General Purpose Input-Output (GPIO)

pins.
3. Programs to interface 8-Bit LED and control them.
4. Interfacing real time clock and serial port.
5. Keyboard (4X4 matrix) Interface to ARM Processor.
6. LCD Interface to ARM Processor.
7. Interfacing EPROM and interrupt programming in ARM Processor.
8. Stepper motor Interface to ARM Processor
9. Assembly program for Mailbox.
10. Generation of PWM Signal

Cycle II:

Experiments:

1. Design of CMOS Inverter &two input NAND Gate.
2. Design of Half Adder using NAND Gates
3. Design a Full Adder using transmission gate logic.
4. Design a Schmitt trigger circuit using CMOS logic
5. Design of 4-bit Adder using Full Adder.
6. Design a 4bit barrel shifter
7. Design of 4-bit thermometer to Binary Code converter.
8. Design and draw the layout of above Digital Circuits.
9. Analyze a two-level RC interconnect circuit for a step input
10. Analyze a tree level inductive interconnect model circuit
11. Design a common source amplifier and find its characteristics.
12. Design a current mirror circuits using MOSFET.

SEMINAR – I

EC 461

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Outcomes: *At the end of this course, students will be able to:*

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

SEMESTER - II

VLSI DESIGN VERIFICATION AND TESTING

EC 103

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To Develop Structural, Dataflow and Behavioral Modeling of Verilog HDL.*
2. *To Know Basics of System Verilog and Familiarize with Object Oriented Programming*
3. *To Explore Randomization and Threads in System Verilog an also, to Know Test Coverage in System Verilog*

Outcomes: *At the end of this course, students will be able to:*

1. *To Realize and Verify Combinational and Sequential Circuits in Verilog HDL*
2. *To Construct User Defined Data Types in System Verilog*
3. *To Create Object Oriented Programming Environment*
4. *To Demonstrate Randomization and Coverage Concepts of System Verilog*
5. *To Propose Efficient Testable Digital Systems in System Verilog*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction to Verilog *Verilog Basics:* Modules and Ports, Structural, Data Flow, Behavioral and switch level Modeling, Tasks and Functions, Logic Synthesis, Timing Delays. *Static timing analysis:* Setup time & hold time violations, clock skew.
UNIT – II
Introduction to Verification *Verification guidelines:* Verification Process, Test bench creation, Significance of Verification, Verilog for verification. *Introduction to System Verilog:* Advantages over Verilog, Methodology, Randomization basics, Coverage basics *Data Types:* Built-in data types, Fixed and dynamic Arrays, Queues, Associative Arrays, Enumerated data types, Procedural statements, Time values.
UNIT – III
Introduction to Object Oriented Programming (OOP): Communication between the Test bench and DUT, Interface Construct, Stimulus Timing, Interface Driving and Sampling, Programming block basics, System Verilog assertions.

OOP: Object Oriented Programming significance and advantages, classes, objects, object handles, methods, Static and Global Variables, using one class inside another class, Dynamic objects, copying objects, Public Vs Local and Building a test bench, Tasks and Functions.
UNIT – IV
Verification using System Verilog *Randomization:* Significance, randomization in system Verilog, Constraint randomization, atomic stimulus generation, random number generation, constraint tips and techniques. *Threads:* Threads, inter process communication, Events, Semaphores, Mailboxes virtual methods, Copying an Object, Inheritance, Abstract Classes and Pure Virtual Methods. Case study using Verification Machine.
UNIT – V
Advanced System Verilog: Callbacks, Parameterized Classes, Static and Singleton Classes *Coverage:* Introduction, Coverage Types, Functional Coverage Strategies, cover group, defining cover groups in classes, Data sampling, coverage points, Coverage methods, Cross coverage, Case study using Universal Verification Machine (UVM).

References:

1	Ming-Bo Lin., "*Digital System Designs and Practices Using Verilog HDL and FPGAs"*, Wiley India, 2008.
2	Samir Palnitkar, "*Verilog HDL: A Guide to Digital Design and Synthesis"*, Pearson Education, 2005.
3	Christ Spear and Greg Tumbush, "*System Verilog for Verification"*, 3rd ed., Springer, 2012.

EMBEDDED SYSTEMS AND REAL TIME OPERATING SYSTEMS

EC 403

Instruction 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To gain Knowledge to design Embedded Systems and tool chain for embedded systems*
2.	*To understand the importance of all Real Time Operating Systems and RTOS in building real time systems*
3.	*To get familiar with the standards like POSIX.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Design an Embedded system.*
2.	*Use embedded software tools for designing embedded system applications.*
3.	*Understand compatibility of RTOS with hardware targets.*
4.	*Apply their understanding in building real time systems.*
5.	*Able to design an embedded system with RTOS.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction to Embedded Systems and design life cycle: Introduction to embedded systems, Embedded design life cycle, Product Specification, Hardware/Software Partitioning, Iteration and Implementation, Detailed Hardware and Software Design, Hardware/Software Integration, Product Testing and Release, Maintaining and Upgrading Existing Products.

UNIT – II

A Basic Toolset: Host-Based Debugging, Remote Debuggers and Debug Kernels, ROM Emulator, Logic Analyzer, Bullet -Proof Run Control, Real-Time Trace, Hardware Breakpoints, Overlay Memory.

UNIT – III

Embedded Operating Systems: Concepts, Differences between Traditional OS and RTOS. Realtime System Concepts, Hard versus Soft Real-time systems – examples, Jobs & Processors, Hard and Soft timing, constraints, Hard Real-time systems, Soft Real-time systems. Classical Uniprocessor Scheduling Algorithms – RMS, Preemptive EDF, Allowing for Preemptive and Exclusion Condition.

UNIT – IV

Portable Operating System Interface (POSIX) – IEEE Standard 1003.13 & POSIX real time profile. POSIX versus traditional Unix signals, overheads and timing predictability. Tasks and Task States, Tasks and Data, Semaphores and Shared Data, Message Queues, MailBoxes and

Pipes, Timer Functions, Events, Memory Managements, Interrupt Routines in RTOS Environment.
UNIT – V
Commercial RTOS: VxWorks, µC/OS-II and RT Linux for Embedded Applications, Case Studies of Embedded Systems.

References:

1	Arnold Berger, *"Embedded Systems Design*", First South asian edition
2	David E Simon, *"An Embedded Software primer",* Low Price Edition, Pearson Education.
3	Betcnhof, D.R., *"Programming with POSIX threads"*, Addison - Wesley Longman, 1997.
4	Wind River Systems, "*VxWorks Programmers Guide",* Wind River Systems Inc.1997.
5	Jean.J.Labrosse, "*MicroC/OS-II*", The CMP Books.
6	Jane W.S.Liu, *"Real Time Systems*", Pearson Education, Asia, 2001

PROGRAM SPECIFIC ELECTIVE - III

VLSI PHYSICIAL DESIGN

EC 414

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*Draw the structure of passive active components*
2.	*Know the concepts of physical design and understand the layouts and stick diagrams of complex circuits*
3.	*Understand the system level physical design and floor planning and hands-on experience on CAD tools*

Outcomes: *At the end of this course, students will be able to:*

1.	*Understand the basic theory of BJT MOS transistors*
2.	*Understand the basic concepts of physical design, layouts of BJT, MOS transistors and interconnect issues*
3.	*Students are able to slove the performance issues in circuit layout*
4.	*Able to analyze physical design problems and employ for partitioning, floor planning, placement and routing*
5.	*Students are able to analyze circuits using both analytical and CAD tools*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Scope of physical design, Components of VLSI, Various layers of VLSI, Typical structures of BJTS, MOSFETS, Resistors, capacitors, inductors, interconnects, brief review of technology, cost and performance analysis.
UNIT – II
Basic concepts of Physical Design, layout of basic structures wells, FET, BJT, resistors, capacitors, contacts, vias and wires (Interconnects). Mask overlays for different structures. Parasitics, latch up and its prevention. Device matching and common centroid techniques for analog circuits.
UNIT – III
Design rules, fabrication errors, alignment sequence and alignment inaccuracies, process variations and process deltas, drawn and actual dimensions and their effect on design rules– scalable design rules. Scalable CMOS (SCMOS) design rules, layout design, and stick diagrams, Hierarchical stick diagrams.

UNIT – IV
Cell concepts, cell-based layout design, Weinberger image array, physical design of logic gates –NOT, NAND and NOR – design hierarchies. System level physical design, large scale physical design, interconnect delay modelling, floor planning, routing and clock distribution.
UNIT – V
CAD Tools: Layout editors, Design rule checkers, circuit extractors, Hierarchical circuit extractors, Automatic layout tools, modelling and extraction of circuit parameters from physical layout. Input-Output Interfacing: Power Supply, Bonding pad, Pad Ring, Input structures, Digital output structures, Low Voltage Differential swing, Power clamp, Core/Pad Limitation, Signal Propagation between Integrated Circuits.

References:

1	John P. Uyemura, "*Introduction to VLSI Circuits and Systems*", John Wiley & sons, Inc.2012.
2	Wayne Wolf, *"Modern VLSI Design (System-on-Chip)",* Pearson Education, 3rd Edition 2005.
3	R. Jacob Baker; Harry W.Li., David E. Boyce, *"CMOS Circuit Design, Layout and Simulation",* IEEE Press, Prentice Hall of India.
4	Etienne Sicard Sonia Delmas Bendhia "*Advanced CMOS Cell Design"* Tata McGraw Hill First Edition 2007.
5	Preas, M. Lorenzatti, *"Physical Design and Automation of VLSI Systems",* the Benjamin Cummins Publishers, (1998).

INTERNET OF THINGS

EC 116

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To understand Smart Objects and IoT Architectures and learn about various IOT-related protocols*
2. *To build simple IoT Systems using Arduino and Raspberry Pi*
3. *To understand data analytics, cloud in the context of IoT and to develop IoT infrastructure for popular applications*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand the concepts of Internet of Things*
2. *Analyze basic protocols in wireless sensor network*
3. *Design IoT applications in different domain and be able to analyze their performance*
4. *Implement basic IoT applications on embedded platform*
5. *Understand the concepts of industrial applications*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Fundamentals of IoT: Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects.

UNIT – II

IoT Protocols IoT access technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.

UNIT – III

*Design and development design methodology***:** Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming -

Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.
UNIT – IV
Data analytics and supporting services: Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG Developing.
UNIT – V
*Case studies/industrial applications***:** Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

References:

1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, *"IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things*", Cisco Press, 2017
2	Vijay Madisetti, Arshdeep Bahga, *"Internet of Things: A Hands-On Approach*"

PROGRAM SPECIFIC ELECTIVE - IV

VLSI TECHNOLOGY

EC 415

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To understand about the review of history of VLSI Technology progress.
2. To analyze the process of realization of BJT and FET on an IC.
3. To gain the knowledge related to Silicon Wafer Preparation and its various processes

Outcomes: *At the end of this course, students will be able to:*

1. Learn about the history of VLSI Technology progress since its inception
2. Understand the process realization of BJT on an IC.
3. Gain knowledge related realization of BJT on an IC.
4. Understand the process related to realization of FET on an IC.
5. Gain knowledge related to Ion implantation, Diffusion and Packaging processes

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction – Integrated Circuits Review of history of VLSI technology progress–. Electronic Functions –Components – Analog and Digital ICs. Basic Devices in ICs – Structures, Resistors – Capacitors – Inductors. Diodes – Bipolar Junction Transistors – Field Effect Transistors, Isolation techniques in MOS and bipolar Technologies.
UNIT – II
Monolithic ICs – Silicon as the Base Material and its advantages, Crystal Structure of Si , various Layers of ICs – Substrate – Active Layer -Oxide/Nitride Layers – Metal/Poly Silicon Layers – Functions of each of the layers. Process flow for Realization of Devices, Description of Process Flow for Typical Devices viz., FET and BJT**.**
UNIT – III
Silicon Wafer Preparation – Electronic Grade Silicon – CZ and FZ Methods of Single Crystal Growth – Silicon Shaping – Prefabrication Processes. Epitaxy: Growth Dynamics – Process Steps, Vapor phase, Solid phase and Molecular Beam Epitaxial Processes, Oxide Growth: Structure of SiO2, Growth Mechanism and Dynamics –Oxide Growth by Thermal method.
UNIT – IV
Deposition techniques Chemical Vapor Deposition (CVD), PVD thermal evaporation,

Lithography: Steps involved in Photolithography – Quality of the Pattern – photo resists and their Characteristics, X-ray – Electron Beam Lithography. Etching: Chemical, Electro Chemical – Plasma (Dry Etching) Reactive Plasma Etching.
UNIT – V
Ion implantation: Range and Penetration Depth – Damage and Annealing – Ion Implantation machine. Diffusion: Constant and Infinite Source Diffusions – Diffusion Profiles – Diffusion Systems – Multiple Diffusions and Junction Formations, Clean rooms.

References:

1	S.M. Sze., "*VLSI Technology",* Mc Grawhill International Editions.
2	CY Chang and S.M. Sze, "*VLSI Technology",* TataMcGraw-Hill Companies Inc.
3	J.D.Plummer, M.D.Deal and P.B.Griffin, *"The Silicon VLSI Technology Fundamentals, Practice and modeling"*, Pearson Education 2009
4	Stephen A, Campbell and Elliot D. Kaplan, *"Understanding GPS Principles and Applications"*, Artech House Boston, 1996. The Science and Engineering of Microelectronic Fabrication, Oxford 20015

AUDIT COURSE –II
DISASTER MANAGEMENT

AC 105

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters*
2. *To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters*
3. *To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.*

Outcomes: *At the end of this course, students will be able to**:***

1. *Learn to demonstrate a critical understanding of key concepts in disaster risk reduction*
2. *Humanitarian response*
3. *Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.*
4. *Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.*
5. *Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in**.***

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.
UNIT – II
Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. *Natural Disasters:* Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT – III
Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics
UNIT – IV
Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.
UNIT – V
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

References:

1	R. Nishith, Singh AK, *"Disaster Management in India: Perspectives, issues and strategies"*, New Royal Book Company.
2	Sahni, Pardeep (Eds.), *"Disaster Mitigation Experiences and Reflections"*, PHI, New Delhi.
3	Goel S. L., *"Disaster Administration and Management Text and Case Studies",* Deep & Deep Publication Pvt. Ltd., New Delhi.

PEDAGOGY STUDIES

AC 106

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *To present the basic concepts of design and policies of pedagogy studies.*
2. *To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices and familiarize various theories of learning and their connection to teaching practice.*
3. *To create awareness about the practices followed by DFID, other agencies and other researchers and provide understanding of critical evidence gaps that guides the professional development*

Outcomes: *At the end of this course, students will be able to:*

1. *Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.*
2. *Examine the effectiveness of pedagogical practices.*
3. *Understand the concept, characteristics and types of educational research and perspectives of research.*
4. *Describe the role of classroom practices, curriculum and barriers to learning.*
5. *Understand Research gaps and learn the future directions.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT – II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT – III

*Evidence on the Effectiveness of Pedagogical Practices***:** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT – IV
Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.
UNIT – V
Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

References:

1	Ackers J, Hardman F, *"Classroom Interaction in Kenyan Primary Schools, Compare*", 31 (2): 245 – 261, 2001.
2	2. Agarwal M, *"Curricular Reform in Schools: The importance of evaluation*", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3	Akyeampong K, "*Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)",* Country Report 1. London: DFID, 2003.
4	Akyeampong K, Lussier K, Pryor J, Westbrook J, *"Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?"* International Journal Educational Development, 33 (3): 272- 282, 2013.
5	Alexander R J, *"Culture and Pedagogy: International Comparisons in Primary Education",* Oxford and Boston: Blackwell, 2001.
6	Chavan M, Read India: *"A mass scale, rapid, learning to read campaign",* 2003

STRESS MANAGEMENT BY YOGA

AC 107

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. *Creating awareness about different types of stress and the role of yoga in the management of stress.*
2. *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
3. *Prevention of stress related health problems by yoga practice.*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through asanas.*
5. *Improve work performance and efficiency.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.
UNIT – II
Meaning and Definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.
UNIT – III
Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress
UNIT – IV
Asanas - (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.
UNIT – V
Pranayama - Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama. *Meditation Techniques:* Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

References:

1	Janardhan Swami Yogabhyasi Mandal, "*Yogic Asanas for Group Training - Part-I*", , Nagpur.
2	Advaita Ashrama, "*Swami Vivekananda, "Rajayoga or Conquering the Internal Nature",* (Publication Department), Kolkata.
3	Nagendra H.R and Nagaratna R, "*Yoga Perspective in Stress Management",* Swami Vivekananda Yoga Prakashan, Bangalore.

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

AC 108

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Outcomes: *At the end of this course, students will be able to:*

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I
Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)
UNIT – II
Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.
UNIT – III
Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48
UNIT – IV
Statements of Basic Knowledge - Shrimad Bhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.
UNIT – V
Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

[PTO]

References:

1	"*Srimad Bhagavad Gita",* Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2	P.Gopinath, *"Bhartrihari's Three Satakam (Niti-sringar-vairagya*)", Rashtriya Sanskrit Sansthanam, New Delhi

VLSI DESIGN, VERIFICATION AND RTOS LABORATORY

EC 452

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Objectives:

1.	*To Develop Structural, Dataflow and Behavioral Modeling of Verilog HDL.*
2.	*To Know Basics of System Verilog and to Familiarize with Object Oriented Programming*
3.	*To Explore Randomization and Threads in System Verilog and to Know Test Coverage in System Verilog*

Outcomes: *At the end of this course, students will be able to:*

1.	*To realize and verify combinational and sequential circuits in Verilog HDL*
2.	*To construct user defined data types in system Verilog and create object-oriented programming environment*
3.	*To demonstrate randomization and coverage concepts of system Verilog*
4.	*Design and develop real-time applications using VxWorks workbench*
5.	*Design and implement digital system on Zynq evaluation boards*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

CYCLE - I

1. Implement a 4-bit pseudo-random Binary sequence generator using a linear feedback shift register with test bench?

2. Implement a 8-bit register with shift left and shift right modes of operation and test the logic with help of test bench?

3. Write Verilog program for cooking-gas delivery with following considerations (with signals request, wait, grant, fine)
   d) Difference between two successive deliveries should be minimum of 15 days.
   e) If user requests before 15 days, wait should be asserted
   f) If user requests when wait is asserted, fine should be asserted

4. Generate Clock signal and write Verilog code for calculating frequency of clock signal?

5. Generate clock signal and write Verilog code for skipping two clock cycles at a time and for every two clock cycles the output should be raising edge?

6. Prepare a LUT it contains the Train information such as train number, train time, number of sleeper classes and number of AC classes. Write a Verilog code when user select the Train number the output should display the train information from the prepared LUT?

7. Write SV code for
   c. Class creation
   d. Class instance and object Creation
   e. Accessing class properties and methods
   f. Class Constructors

8. Write a SV code demonstrating access to static class properties and methods

9. Write a SV code for
   c. Parent class properties accessed using child class handle.
   d. Parent class method is *overridden* in the child class.

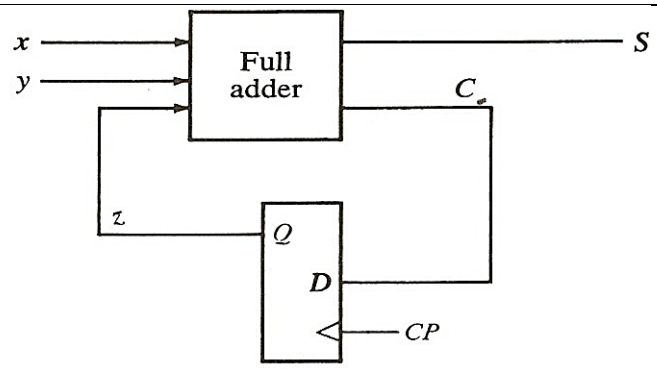
10. Write a system Verilog code to show the usage of *local* keyword and *protected* keyword within and outside a class.

11. Write a SV codes for
    c. Creating abstract classes
    d. Accessing Static class member using class resolution operator

12. Define a base class with Half Adder as a Function.
    c. Write the extended class for Full adder using the base class.
    d. Write a module defining the functionality for 4 bit Ripple carry adder.

13. Define a parent class with a 32 bit protected parameter ***tmp_addr***
4. Write a child class containing
   j. A constructor to initialize the parameter "***tmp_addr***".
   iii. A function to increment the parameter "***tmp_addr***".
5. Write a module showcasing the usage of protected variable "***tmp_addr***" after incrementing its address.

14. Define a base class with Full Adder as a Function.
    c. Write the extended classes for D Flipflop.
    d. Write a module defining the functionality for the following circuit.



15. Write constraint to create four random numbers **a, b, c, d**.
    i. "**a**" should be less than 5000 and greater than 100, and should not be divisible by 2
    ii. "**b**" should be less than 5,000 and should be divisible by 5
    iii. "**c**" should be in the range of 1 to 5 and include the expression [(a-b) : (a+b))]
    iv. "**d**" should be greater than all a, b and c.

16. Write a SV code for
    e. cover group
    f. cover point
    g. cross
    h. bin

CYCLE - II

Part A: Programs Using VxWorks Workbench (Real Time Operating System)

1. Multi-Tasking
2. Round Robin Scheduling
3. Ipc Using Semaphore
4. Ipc Using Message Queues
5. Preemptive Priority Based Task Scheduling
6. Priority Inversion
7. Interrupt Service Routines

Part B: HDL Simulation & Implementation on Zynq

1. 8:1 Mux/Demux,
2. Full Adder
3. 8-bit Magnitude comparator,
4. Encoder/decoder, Priority encoder,
5. D-FF, 4-bit Shift registers (SISO, SIPO, PISO, bidirectional),
6. 3-bit Synchronous Counters,
7. Parity generator.
8. Sequence Detector

SEMINAR – II

EC 462

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 1.5

Outcomes: At the end of this course, students will be able to**:**

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, and discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

MINI PROJECT WITH SEMINAR

EC 471

Instruction: 6 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits: 3

Outcomes: *At the end of this course, students will be able to:*

1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained
5. Write the documentation in standard format

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter-disciplinary/ industry relevance.
- The students can select a mathematical modelling based/Experimental investigations or Numerical modelling
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

SEMESTER - III

PROGRAM SPECIFIC ELECTIVE - V

ANALOG AND MIXED SIGNAL IC DESIGN

EC 119

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To Design Basic Building Blocks of Opamp: Current Mirror, Single Stage Amplifiers*
2.	*To Design and Analyze Two-Stage Opamp and familiarize with Folded Cascade Opamps*
3.	*To Know Applications of Opamps and learn Data Converters and Phased Locked Loops (PLL)*

Outcomes: *At the end of this course, students will be able to:*

1.	*To Develop Mathematical Modeling of Building Blocks of Opamps*
2.	*To Design and Simulate Two-Stage Opamp for the Given Specifications*
3.	*To Analyze the Performance of Operational Trans-Conductance Amplifier.*
4.	*To Develop Switched Capacitor Circuits*
5.	*To Outline the Principle of Operation of Over-Sampling Rate A/D and D/A Converters*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Building Blocks of Opamp:

MOS Transistor – Nanometer Transistor and its model – body effect, Channel Length Modulation and short channel effects – velocity saturation, sub-threshold conduction, threshold voltage control, drain induced barrier lowering, gate induced drain leakage, Complete MOS Transistor Model and large and small signal models of BJTs and MOSFETs.

Current Mirrors and Single Stage Amplifiers – Simple CMOS current mirror, common source amplifier, source follower, common gate amplifier, cascade amplifiers. Source de-generated current mirrors, cascade current mirror, cascade gain stage and MOS differential pair and gain stage.

Biasing and References – Analog IC biasing, establishing constant trans-conductance and band-gap reference – Positive and negative temperature coefficient basics and circuits.

UNIT – II

Basic Opamp and Compensation: Basic two-stage MOS Operational amplifier, characteristic parameters, compensation, design and analysis of two-stage MOS Opamp with given

specifications. Stability and frequency compensation of op-amps.
UNIT – III
Operational Trans-conductance Amplifier (OTA): *Advanced current Mirrors* – Wilson current mirror, Enhanced output-impedance current mirror and gain boosting and wide swing current mirror with enhanced output impedance and bipolar current mirrors – bipolar gain stages. *Single stage Opamp* – Folded-cascade Opamp, current mirror Opamp, fully differential Opamp and common mode feedback circuits.
UNIT – IV
Applications of Opamp *Comparators:* Op-Amp Based Comparators, Charge Injection Errors – Latched Comparators – CMOS and BiCMOS Comparators – Bipolar Comparators. *Switched capacitor circuits:* Basic building blocks; basic operation and analysis, inverting and non-inverting integrators, signal flow diagrams, first order filter. *Sample and hold circuits* - Performance requirements, MOS sample and hold basics, clock feed through problems, S/H using transmission gates, high input impedance S/H circuits, improved S/H circuits from the point of slewing time, clock feed through cancellations.
UNIT – V
Mixed Signal IC Applications: *Data Converters* – Review of Nyquist-Rate A/D and D/A converters, Noise Sources: Flicker, Thermal, Oversampling converters – Over sampling without noise shaping and with noise shaping, system architectures and digital decimation filters. *Phase locked loops* – simple PLL, charge pump PLL and dynamics of PLL. *Practical Issues* – Transistor mismatch, offset and techniques to reduce the analog non-idealities (like auto-zero, chopping, CDS etc) and Basics of Analog Layout

References:

1	Tony Chan Carusone, David Johns and Ken Martin, "*Analog Integrated Circuit Design*", 2nd edition, John Wiley & sons. 2013.
2	Behzad Razavi, "*Design of Analog CMOS Integrated Circuits*", McGraw Hill Companies, 2013.
3	Philip E. Allen and Douglas R. Holberg, "*CMOS Analog Circuit Design*", 2nd edition, Oxford University Press, 2010.

LOW POWER VLSI DESIGN

EC 118

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. *To study the sources of power dissipation and low power design techniques with voltage scaling and capacitance minimization approaches*
2. *To study various low power arithmetic units and the design of low power multipliers*
3. *To study about low power memory technologies*

Outcomes: *At the end of this course, students will be able to:*

1. *Understand various power components*
2. *Understand and design low power memories*
3. *Understand and use mathematical models for power analysis in CMOS circuits*
4. *Design low power architectures*
5. *Realize low power low voltage adder and multipliers*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Fundamentals: Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

UNIT – II

*Low-Power Design Approaches***:** Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance Minimization Approaches: System Level Measures and Circuit Level Measures.

UNIT – III

*Low-Voltage Low-Power Adders***:** Introduction, Standard Adder Cells, CMOS Adder Architectures – Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Low-Power Design Techniques–Trends of Technology and Power Supply Voltage, Low-Voltage Low-Power Logic Styles

UNIT – IV
Low-Voltage Low-Power Multipliers: Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh-Wooley Multiplier, Booth Multiplier and Introduction to Wallace Tree Multiplier.
UNIT – V
*Low-Voltage Low-Power Memories***:** Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Pre-charge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM.

References:

1	Sung-Mo Kang, Yusuf Leblebici, *"CMOS Digital Integrated Circuits – Analysis and Design"*, TMH, 2011.
2	Ming-BO Lin, "*Introduction to VLSI Systems: A Logic, Circuit and System Perspective",* CRC Press, 2011
3	Anantha Chandrakasan, *"Low Power CMOS Design*", IEEE Press/Wiley International, 1998
4	Kaushik Roy, Sharat C. Prasad, *"Low Power CMOS VLSI Circuit Design*", John Wiley & Sons, 2000.
5	Gary K. Yeap, "*Practical Low Power Digital VLSI Design*", Kluwer Academic Press, 2002.

PRINCIPLES OF EMBEDDED SYSTEMS AND VLSI DESIGN

OE 904

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1.	*To gain knowledge to design embedded systems.*
2.	*To study the software architecture of embedded systems and to gain the knowledge of tool chain for embedded systems.*
3.	*To Develop Structural, Dataflow and Behavioral Modeling of Verilog HDL and test any Verilog code for proper functioning of the design.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Design an embedded system.*
2.	*To select an appropriate operating system for embedded system.*
3.	*Use Embedded Software Development Tools for Designing Real Time applications.*
4.	*To Construct Verilog HDL models for combinational and sequential circuits*
5.	*To Realize and Verify Real Time Digital Systems in Verilog HDL*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

UNIT – I

Introduction to Embedded Systems: The Embedded Design Life Cycle – Product Specification, Hardware/Software Partitioning, Iteration and Implementation, Detailed Hardware (selection of processor) and Software Design, Hardware/Software Integration, Product Testing and Release, Maintenance and Upgradation.

UNIT – II

Software Architecture of embedded systems: Round-robin, Round-robin with interrupts, Function-queue-scheduling Architecture, Real time operating system architecture, selecting an Architecture, Shared data problem, Interprocessor Communication using semaphores, pipes, Queues, message box.

UNIT – III

Embedded Software Development Tools: Host and Target Machines, Cross Compilers, Cross Assemblers, Tool Chains, Linkers/Locators for Embedded Software, Address Resolution. Getting Embedded Software into Target System: ROM emulator, In Circuit- Emulators, Instruction Set Simulators, and Logic Analyzers.

UNIT – IV
Introduction to Verilog: Verilog Basics, Modules and Ports, Structural, Data Flow, Behavioral and switch level Modeling, Tasks and Functions, Timing Delays. Static timing analysis: Setup time & hold time violations, clock skew.
UNIT – V
Introduction to Verification: Verification guidelines, Verification Process, Test bench creation, Significance of Verification. Development of Test Bench for combinational and sequential circuits Case Studies using Verilog HDL: Basic CPU, Control Unit, UART etc.

References:

1	Ming-Bo Lin., *"Digital System Designs and Practices Using Verilog HDL and FPGAs",* Wiley India, 2008.
2	Samir Palnitkar, *"Verilog HDL: A Guide to Digital Design and Synthesis*", Pearson Education, 2005.
3	Arnold S Berger, *"Embedded Systems Design",* South Asian edition, CMP Books, 2005.
4	David E Simon, "*An Embedded software primer*", Pearson, 2012.
5	Raj Kamal, *"Embedded Systems: Architecture, programming and Design",* Tata McGrawHill

MAJOR PROJECT PHASE - I

EC 481

Instruction: 20 periods per week *Duration of SEE: --*
CIE: 100 marks *SEE: --*
Credits: 10

Outcomes: *At the end of this course, students will be able to:*

1. Exposed to self-learning various topics.
2. Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.
3. Learn to write technical reports.
4. Develop oral and written communication skills to present.
5. Defend their work in front of technically qualified audience

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, Osmania University and Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

SEMESTER - IV

MAJOR PROJECT PHASE - II

EC 482

Instruction: 32 periods per week *Duration of SEE: --*
CIE: -- *SEE: 200 marks*
Credits: 16

Outcomes: *At the end of this course, students will be able to:*

1.	*Use different experimental techniques and will be able to use different software/ computational /analytical tools.*
2.	*Design and develop an experimental set up/ equipment/test rig.*
3.	*Conduct tests on existing set ups/equipment and draw logical conclusions from the results after analysing them.*
4.	*Either work in a research environment or in an industrial environment.*
5.	*Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.*

Program Articulation Matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Row wise cumulative percentage weightage should be equal to 1.0.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester - III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head, Osmania University and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS & Head, Osmania University (All together	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce